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POM 1998 - 2003
DESCRIPTIVE SUMMARIES

May 1996

DARPA

Defense Advanced Research Projects Agency

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ADVANCED RESEARCH PROJECTS AGENCY
3701 NORTH FAIRFAX DRIVE
ARLINGTON, VA 22203-1714

MAY 21 1996

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: POM 98-03 Submission

Attached is the DARPA Program Objective Memorandum submission covering RDT&E requirements for FYs 1998-2003. This submission is focused on pursuing breakthrough technologies to satisfy warfighter needs, increase the affordability of future weapon systems, and demonstrate advanced systems concepts. The funding levels are consistent with the fiscal guidance.

Larry Lynn
Director

Attachment

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
POM 98-03 SUBMISSION

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SECTION I

EXECUTIVE/ RESOURCE SUMMARIES

Defense Advanced Research Projects Agency
Executive Summary

The DARPA POM 98 submission reflects the Agency's continuing mission: to pursue high-risk, high-payoff technologies to ensure the superiority of tomorrow's warfighters. The POM complies with fiscal guidance, funds DARPA's share of joint projects, and maintains high priority Administration initiatives. A summary of DARPA's major POM emphases follow.

Comprehensive Battlefield Awareness

Much of DARPA's POM focus addresses the old adage that "knowledge is power." Over ten percent of the DARPA POM request is budgeted for programs to improve the planning, coordination and control of joint battlefield forces. Properly harnessed, modern technology can give battlefield commanders greater visibility than was ever possible in the past. Knowledge of where the enemy forces are located, and the position and condition of U.S. forces, will provide a critical tactical advantage. In an era of downsized forces facing global challenges, superior technology may well be the difference between success and failure. DARPA programs in Command and Control Information systems, Information Integration Systems, and Sensors and Exploitation Systems will provide this technological edge.

Knowledge is a force multiplier throughout the DoD system. DARPA research in the medical arena will improve the location and treatment of injured soldiers. It will enhance the logistics system so that the supplies can be tracked from the warehouse to the battlefield. Maintenance costs and downtime can be reduced through the introduction of intelligent sensors at the subsystem and component levels. Finally, to avoid compromise of U.S. information systems by potential adversaries, DARPA has expanded its research in the area of information security and survivability.

Radical Military Concepts

The development of radical military concepts has always been a DARPA hallmark, and the POM 98 submission continues this tradition. Funding is included for DARPA's share of the Arsenal ship, a joint program with the Navy to provide massive off shore firepower in support of shore activities. The potential of hybrid electric powered vehicles is being explored. Such hybrids would allow maximum operating efficiency, quiet ingress and egress for scout vehicles, and centralized power for navigation and targeting systems that are increasingly common in modern military vehicles. Small Unit Operations concepts and required technologies are under investigation. With enhanced communications and accurate positioning data, it is likely that small units can perform missions that once the province of far larger, but less coordinated forces.

Joint Programs and Advanced Concept Technology Demonstrations (ACTDs)

Whenever possible, DARPA has teamed with its Service or Defense Agency counterparts both to leverage the expertise of other researchers and to facilitate transition of the resulting technologies to the Services. The Arsenal ship is but one example of a teaming relationship. Others include the Tier III- High Altitude Endurance Unmanned Aerial vehicle program, a joint DARO/DARPA enterprise; the Joint Task Force Advanced Technology Demonstration; and the massive Simulated Theater of War (STOW) 97 program. ACTDs are also well represented in the DARPA POM such as the Advanced Joint Planning ACTD, Miniature Air Launched Decoy ACTD, and the Battlefield Awareness and Data Dissemination (BADD) ACTD. The BADD program, currently in operation in Bosnia, is an excellent example of an ACTD putting technology to work where it is needed most--in the front lines of American involvement.

Core Research

Tomorrow's weapons systems depend on a robust core research program. DARPA's POM 98 program continues research in high performance computing and intelligent systems and software to ensure the availability of the computing power necessary to reduce the massive data streams from proliferating sensors sources from National systems, airborne sensors, unmanned aerial vehicles, and ground sources. Advanced mathematical programs are developing the algorithms necessary for enhanced automatic target recognition, even when the targets are obscured by camouflage or countermeasures. Improvements in electronic packaging, optolectronics research, and designs that reduce power requirements are driving the next generation of electronics that will be smaller, lighter, cheaper, and therefore more useful for the foot soldier in the field. Microelectromechanical systems have endless potential in roles as diverse as miniature ground sensors to personal navigation aids.

Administration Initiatives

The DARPA POM funds a number of Administration Initiatives at levels established by OSD including the Dual Use Application Program, MARITECH, and Advanced Lithography.

In summary, DARPA's POM 98 submission is a careful blend of technology research and application. It fully supports the mission of DoD both today and tomorrow.

DEFENSED ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PROJECT LEVEL SUMMARY REPORT
($ in millions)

FY 1998-2003 POM

PE	PROJ	TITLE	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
61101E	CCS-02	INFORMATION SCIENCES	23.072	22.103	23.539	19.005	18.900	20.900	20.400	23.700	20.700
	ES-01	ELECTRONIC SCIENCES	34.402	37.288	39.684	42.304	41.345	36.478	32.533	31.533	37.533
	MS-01	MATERIALS SCIENCES	27.098	17.365	11.700	15.000	17.691	19.622	19.953	21.053	21.053
	61101E	**DEFENSE RESEARCH SCIENCES**	**84.572**	**76.756**	**74.923**	**76.309**	**77.936**	**77.000**	**72.886**	**76.286**	**79.286**
62301E	ST-01	JASONS	1.227	1.163	1.196	1.190	1.200	1.200	1.200	1.200	1.200
	ST-11	INTELLIGENT SYSTEMS & SOFTWARE	73.569	86.466	98.441	108.050	110.481	110.256	127.007	143.007	147.007
	ST-19	HIGH PERFORMANCE COMPUTING	234.114	186.410	191.150	195.029	206.157	218.481	261.411	279.192	297.192
	ST-22	SOFTWARE ENGINEERING TECHNOLOGY	38.424	25.519	18.072	19.609	20.196	20.803	21.428	21.428	21.428
	ST-23	MONITORING TECHNOLOGIES	19.525	27.891	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ST-24	INFORMATION SURVIVABILITY	9.877	26.243	38.098	45.812	46.113	50.115	55.046	70.654	75.000
	62301E	**COMPUTING SYS & COMM TECHNOLOGY**	**376.736**	**353.692**	**346.957**	**369.690**	**384.147**	**400.855**	**466.092**	**515.481**	**541.827**
62702E	TT-03	NAVAL WARFARE TECHNOLOGY	48.514	39.191	32.639	29.841	38.000	58.553	59.172	79.172	89.172
	TT-04	ADVANCED LAND SYSTEMS TECHNOLOGY	28.335	35.780	22.125	28.000	41.000	44.909	59.686	75.686	69.886
	TT-05	ADVANCED TARGETING TECHNOLOGY	5.916	7.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TT-06	ADVANCED TACTICAL TECHNOLOGY	36.409	37.403	45.995	60.753	61.418	57.024	62.728	72.728	82.728
	TT-07	AERONAUTICS TECHNOLOGY	0.000	0.000	0.000	20.000	40.000	40.000	42.811	45.000	55.000
	TT-10	ADVANCED LOGISTICS TECHNOLOGY	0.000	6.328	17.185	23.685	21.665	10.633	10.000	10.000	0.000
	62702E	**TACTICAL TECHNOLOGY**	**119.174**	**125.702**	**117.944**	**162.279**	**202.083**	**211.119**	**234.397**	**282.586**	**296.786**
62708E	**IC-03**	**INTEGRATED COMMAND & CONTROL TECH**	**79.375**	**47.329**	**45.000**	**45.000**	**45.000**	**45.000**	**45.000**	**0.000**	**0.000**
62712E	MPT-01	MATERIALS PROCESSING TECHNOLOGY	140.900	117.441	110.208	110.976	140.797	147.550	163.327	193.327	204.327
	MPT-02	MICROELECTRONIC DEVICE TECHNOLOGIES	87.440	56.758	71.824	77.931	95.660	96.222	98.881	110.972	120.972
	MPT-06	CRYOGENIC ELECTRONICS	16.820	29.568	9.835	13.190	13.203	12.546	15.000	20.000	25.000
	MPT-07	MILITARY MEDICAL/TRAUMA CARE TECHNOLOGY	14.632	27.992	26.672	26.714	37.686	54.407	55.500	59.500	58.500
	62712E	**MATERIALS & ELECTRONICS TECHNOLOGY**	**259.792**	**231.759**	**218.539**	**228.811**	**287.346**	**310.725**	**332.708**	**383.799**	**408.799**

Exhibit C-1

DEFENSED ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PROJECT LEVEL SUMMARY REPORT
($ In millions)

FY 1998-2003 POM

PE	PROJ	TITLE	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
63226E	EE-21	COMMAND & CONTROL INFORMATION SYSTEMS	53.934	44.445	47.765	67.300	72.100	79.169	90.034	99.034	99.034
	EE-27	AEROSPACE SURVEILLANCE TECHNOLOGIES	8.381	3.000	0.000	17.000	14.000	12.000	16.200	25.000	27.000
	EE-34	GUIDANCE TECHNOLOGY	8.912	11.876	10.499	21.100	21.100	28.112	30.800	35.200	52.000
	EE-36	ADVANCED SHIP/SENSOR SYSTEMS	31.975	24.314	18.844	20.330	44.096	81.478	89.696	109.696	119.696
	EE-37	ADVANCED SIMULATION	73.948	61.040	48.419	32.912	21.798	0.000	0.000	0.000	0.000
	EE-39	UNMANNED UNDERSEA VEHICLE SYSTEMS	33.901	15.234	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	EE-40	CRITICAL MOBILE TARGETS	109.437	110.683	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	EE-41	AIR DEFENSE INITIATIVE	34.109	25.564	21.777	0.000	0.000	0.000	0.000	0.000	0.000
	EE-45	GLOBAL GRID COMMUNICATIONS	43.236	42.807	42.024	43.392	43.916	44.750	49.549	54.549	49.549
	EE-46	DEFENSE SIMULATION INTERNET (DSI)	14.591	25.612	39.675	3.000	0.000	0.000	0.000	0.000	0.000
	EE-47	FAST SHIP/FUTURE SHIP	0.000	0.000	16.382	47.618	50.000	36.000	22.000	0.000	0.000
	EE-48	COMBAT HYBRID POWER SYSTEM	0.000	0.000	15.000	25.000	28.500	18.000	17.000	0.000	0.000
	EE-49	TIER III UAV	0.000	23.201	14.749	5.000	0.000	0.000	0.000	0.000	0.000
	EE-50	SENSORS & EXPLOITATION SYSTEMS	0.000	0.000	69.201	85.854	92.755	109.400	116.787	135.287	135.287
	EE-51	SMALL UNIT OPERATIONS	0.000	18.486	52.666	52.580	69.897	72.913	70.000	70.000	40.000
	EE-53	INFORMATION INTEGRATION SYSTEMS	0.000	0.000	67.914	98.400	105.300	105.000	121.000	118.800	110.000
	EE-CLS	CLASSIFIED	169.394	174.946	170.638	165.551	87.655	85.440	82.648	85.648	80.648
	63226E	**EEMIT**	**581.818**	**581.208**	**635.553**	**685.037**	**651.117**	**672.262**	**705.714**	**733.214**	**713.214**
63569E	**AS-01**	**ADVANCED SUBMARINE TECHNOLOGY**	**31.400**	**31.455**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
63570E	**PT-01**	**DEFENSE REINVESTMENT**	**208.067**	**181.623**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
63739E	MT-02	MIMIC	20.472	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	MT-03	INFRARED FOCAL PLANE ARRAY	42.979	39.493	23.995	9.000	14.000	0.000	0.000	0.000	0.000
	MT-04	ELECTRONIC MODULE TECHNOLOGY	112.953	96.674	66.149	73.206	97.590	150.760	188.012	195.140	199.525
	MT-05	TACTICAL INFORMATION SYSTEMS	13.978	20.912	19.076	34.884	35.646	31.000	27.500	27.500	27.500
	MT-06	MICROWAVE & ANALOG FRONT END TECHNOLOGY	19.475	39.858	47.921	48.071	39.000	25.000	0.000	0.000	0.000
	MT-07	CENTERS OF EXCELLENCE	35.381	16.884	14.000	0.000	0.000	0.000	0.000	0.000	0.000
	MT-08	MANUFACTURING TECHNOLOGY APPLICATIONS	47.692	59.507	34.051	33.455	25.000	21.951	10.000	10.000	10.000
	MT-10	ADVANCED LITHOGRAPHY	56.321	46.109	51.404	40.000	40.000	40.000	40.000	37.500	35.754
	MT-11	ELECTRONIC COMMERCE RESOURCE CENTERS	33.755	31.073	20.704	15.000	0.000	0.000	0.000	0.000	0.000
	MT-12	MEMS	0.000	29.514	54.800	75.060	71.549	69.281	60.000	50.000	50.000
	63739E	**ADVANCED ELECTRONICS TECHNOLOGIES**	**383.006**	**380.024**	**332.100**	**328.676**	**322.785**	**337.992**	**325.512**	**320.140**	**322.779**

Exhibit C-1

DEFENSED ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PROJECT LEVEL SUMMARY REPORT
($ in millions)

FY 1998-2003 POM

PE	PROJ	TITLE	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
63744E	SM-01	ADVANCED SIMULATION - NATIONAL GUARD	27.579	4.781	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63745E	EM-01	SEMICONDUCTOR MANUFACTURING TECHNOLOGY	88.327	36.531	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63746E	MR-01	MARITIME TECHNOLOGY	40.418	46.351	37.408	50.000	0.000	0.000	0.000	0.000	0.000
63747E	EV-01	ELECTRIC VEHICLES	14.170	14.694	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63800E	JA-01	JOINT STRIKE FIGHTER	0.000	28.917	78.400	0.000	0.000	0.000	0.000	0.000	0.000
63805E	GC-01	DUAL USE APPLICATIONS PROGRAMS	0.000	0.000	250.000	195.000	175.000	145.000	75.000	0.000	0.000
63889E	CD-01	COUNTERDRUG	38.970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65114E	BL-01	BLACKLITE	4.725	4.623	4.730	4.683	5.000	5.000	5.000	5.000	5.000
65502E	SB-01	SMALL BUSINESS INNOVATIVE RESEARCH	0.000	37.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65898E	MH-01	MANAGEMENT HEADQUARTERS (R&D)	29.736	34.099	36.369	37.315	38.486	39.147	39.991	41.594	42.209
99900E	EA-01	EXPIRED ACCOUNT ADJUSTMENTS	3.726	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99999E	CA-01	CANCELLED ACCOUNTS	0.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	AGENCY TOTAL		2371.941	2216.884	2177.923	2182.800	2188.900	2244.100	2302.300	2358.100	2409.900
	BA-01	TOTAL	84.572	76.756	74.923	76.309	77.936	77.000	72.886	76.286	79.286
	BA-02	TOTAL	835.077	758.482	728.440	805.780	918.576	967.699	1078.197	1181.866	1247.412
	BA-03	TOTAL	1413.755	1305.584	1333.461	1258.713	1148.902	1155.254	1106.226	1053.354	1035.993
	BA-06	TOTAL	38.537	76.062	41.099	41.998	43.486	44.147	44.991	46.594	47.209
	AGENCY TOTAL		2371.941	2216.884	2177.923	2182.800	2188.900	2244.100	2302.300	2358.100	2409.900

Exhibit C-1

SECTION II

FORCE STRUCTURE

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY1995 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	196
22 General Research & Development	0	0	0	0	0	0	0	196
223 RDT&E Management & Support	0	0	0	0	0	0	0	196
TOTAL END STRENGTH	0	0	0	0	0	0	0	196

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY1996 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	217
22 General Research & Development	0	0	0	0	0	0	0	217
223 RDT&E Management & Support	0	0	0	0	0	0	0	217
TOTAL END STRENGTH	0	0	0	0	0	0	0	217

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY1997 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	217
22 General Research & Development	0	0	0	0	0	0	0	217
223 RDT&E Management & Support	0	0	0	0	0	0	0	217
TOTAL END STRENGTH	0	0	0	0	0	0	0	217

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY1998 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	217
22 General Research & Development	0	0	0	0	0	0	0	217
223 RDT&E Management & Support	0	0	0	0	0	0	0	217
TOTAL END STRENGTH	0	0	0	0	0	0	0	217

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY1999 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	217
22 General Research & Development	0	0	0	0	0	0	0	217
223 RDT&E Management & Support	0	0	0	0	0	0	0	217
TOTAL END STRENGTH	0	0	0	0	0	0	0	217

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY2000 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	211
22 General Research & Development	0	0	0	0	0	0	0	211
223 RDT&E Management & Support	0	0	0	0	0	0	0	211
TOTAL END STRENGTH	0	0	0	0	0	0	0	211

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY2001 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	207
22 General Research & Development	0	0	0	0	0	0	0	207
223 RDT&E Management & Support	0	0	0	0	0	0	0	207
TOTAL END STRENGTH	0	0	0	0	0	0	0	207

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY2002 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	207
22 General Research & Development	0	0	0	0	0	0	0	207
223 RDT&E Management & Support	0	0	0	0	0	0	0	207
TOTAL END STRENGTH	0	0	0	0	0	0	0	207

Format A-8: Programmed Structure, Programmed Manning, and End Strength

Defense Advanced Research Projects Agency

FY2003 (Quantities in 000's)

DMC	ACTIVE		RESERVE		NATIONAL GUARD		CIVILIAN	
	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning	Programmed Manpower Structure	Authorized Manning
2 DEFENSE-WIDE MISSIONS	0	0	0	0	0	0	0	207
22 General Research & Development	0	0	0	0	0	0	0	207
223 RDT&E Management & Support	0	0	0	0	0	0	0	207
TOTAL END STRENGTH	0	0	0	0	0	0	0	207

SECTION III

MODERNIZATION AND INVESTMENT

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research

R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Research Sciences	**76,756**	**74,923**	**76,309**	**77,936**	**77,000**	**72,886**	**76,286**	**79,286**	**Continuing**	**Continuing**
Information Sciences CCS-02	22,103	23,539	19,005	18,900	20,900	20,400	23,700	20,700	Continuing	Continuing
Electronic Sciences ES-01	37,288	39,684	42,304	41,345	36,478	32,533	31,533	37,533	Continuing	Continuing
Materials Sciences MS-01	17,365	11,700	15,000	17,691	19,622	19,953	21,053	21,053	Continuing	Continuing

(U) **Mission Description**: The Defense Research Sciences program element is budgeted in the Basic Research Budget Activity because it provides the technical foundation for long-term improvements through the discovery of new phenomena and the exploration of the potential of such phenomena for military, national security and commercial applications. It supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic and materials sciences.

(U) The Information Sciences project supports basic scientific study and experimentation in software technology, intelligent systems technology, human-computer interaction technology, facets of microelectronic sciences, and varied aspects of high performance computing.

(U) The Electronic Sciences project explores and demonstrates electronic and optoelectronic device, circuit, and processing concepts that will provide: (1) new technical options for meeting the information gathering, transmission and processing required to maintain near real-time knowledge of the enemy, and the ability to communicate decisions based on that knowledge to all forces in near real-time; and (2) a substantial increase in performance and cost reduction of military systems providing these capabilities.

(U) The Materials Sciences project is concerned with the development of: high power density/energy density mobile and portable power sources (including batteries and fuel cells); far-forward combat casualty care medical technologies; technologies for defense against biological warfare agents; magneto-resistive materials for use in radiation hardened memories and motion sensors; processing and design approaches for nanoscale and/or biomolecular materials and interfaces; and medical pathogen countermeasures.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 1 Basic Research	Defense Research Sciences, PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Sciences CCS-02	22,103	23,539	19,005	18,900	20,900	20,400	23,700	20,700	Continuing	Continuing

(U) **Mission Description:** This project supports the basic scientific study and experimentation that is the basis for more advanced knowledge and understanding in information sciences technology areas such as software foundations and environments, intelligent systems, human computer interface, language technology, microelectronic science, and high performance computing related to long-term national security requirements.

(U) In the area of software technology: advanced concepts are developed for methods and tools to produce high assurance software; language concepts that facilitate the rapid specification and evolution of systems; and techniques to manage shared complex structured data objects in larger heterogeneous, distributed information systems. The intelligent systems technology focus is on advanced techniques for knowledge representation, reasoning, and machine learning, which enables computer understanding of spoken and written language and images. Also included is advanced methods for planning, scheduling, and resource allocation. The focus in the human computer interaction technology area is design methods and enabling technology for more natural interaction between people and computers. Lastly, the high performance computing (HPC) focus is on science generated concepts and methods for validating and verifying design components, and unique approaches to rapidly develop high performance libraries across multiple HPC architectures.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Developed languages and tools to integrate architecture-level representations of software systems and to use these representations for analysis and testing. ($7.5M)
- Enhanced advanced information processing methods in spoken language understanding, written language understanding and automated planning systems. ($3.8M)
- Experimentally evaluated tool kits for interactive, dialogue-based human computer interaction. ($4.2M)
- Refined and begun experimental evaluation of design technology to include high performance computational prototyping of systems. ($3.1M)
- Completed basic research effort in scalable operating systems and services. ($.7M)
- Demonstrated utility of scalable libraries for defense tasking. ($.7M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project CCS-02

- Experimentally evaluated planning and decision aids prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. ($2.1M)

(U) FY 1997 Program:

- Develop initial tools and tool kits for development and evaluation of highly interactive, agent and dialogue-based human computer interactions. ($5.9M)
- Advance the capabilities of spoken and written language understanding to solve real-world problems and provide widely usable functionality. ($7.2M)
- Extend and evaluate large-scale statistical modeling, machine learning, and knowledge representation methods for spoken and written language understanding and develop hub formalization that will infuse existing programming languages with new advances in formal methods. ($1.8M)
- Continue the experimental evaluation of design technology for high performance computational prototyping of systems. ($2.8M)
- Experimentally support software evolution by integrating numerous formal and informal information sources in a "hyperweb"; enhance formal notations for software design to include both syntactic and semantic information; and demonstrate multi-language architecture definition and analysis tools. ($5.8M)

(U) FY 1998 Program:

- Demonstrate symbolic simulation linked with hardware emulation for complex design technology. ($3.0M)
- Demonstrate the experimental evaluation of design technology for high performance computational prototyping of systems, supporting both task and data parallelism for scalable software library technology. ($1.0M)
- Develop robust spoken and text language technologies with emphasis on affordable dialog grammars and understanding in spite of noise; all technology developed in response to systems experiments focused on critical military needs. ($9.0M)
- Develop and demonstrate novel backplane architecture incorporating security. ($1.0M)
- Non-traditional computational engines explored and experimentally validated. ($3.0M)
- Demonstrate the feasibility of using bio-engineering techniques to store & retrieve information. ($2.0M)

(U) FY 1999 Program:

- Demonstrate data transfer from conventional silicon circuits to neural networks. ($4.0M)
- Demonstrate a computational model using bio-engineering techniques. ($5.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project CCS-02

- Develop algorithms to deal with high noise conditions for speech recognition and then evaluate automatic transcription of conversational speech over phone and battlefield radio with a goal of producing a transcript that is human readable. ($3.0M)
- Develop a human interaction and content extraction architecture and demonstrate implementation for crisis action planning and crisis situation identification showing improvement for relevant information access time by an order of magnitude. ($4.9M)
- Demonstrate scalable image analysis applications on networked, open architecture system that will allow the operator to improve the quality of analysis while simultaneously reducing the time for producing an analysis product. ($2.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	24.8	23.5	23.0	22.9
Appropriated	22.4	N/A	N/A	N/A
Current Budget	22.1	23.5	19.0	18.9

(U) **Change Summary Explanation**:

FY 1996 Reductions reflects minor program repricing.
FY 1998-99 Reductions reflect greater emphasis on basic research in Materials Technology.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 1 Basic Research	Defense Research Sciences, PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Sciences ES-01	37,288	39,684	42,304	41,345	36,478	32,533	31,533	37,533	Continuing	Continuing

(U) **Mission Description**: This project seeks to continue the phenomenal progress in microelectronics innovation that has characterized the last decades through exploring and demonstrating electronic and optoelectronic devices, circuits and processing concepts that will: 1) provide new technical options for meeting the information gathering, transmission and processing required to maintain near real-time knowledge of the enemy, and the ability to communicate decisions based on that knowledge to all forces in near-real time, and 2) provide new means for achieving substantial increases in performance and cost reduction of military systems providing these capabilities. Research areas include new electronic and optoelectronic device and circuit concepts, operation of devices at higher frequency and lower power, extension of diode laser operation to new wavelength ranges relevant to military missions, development of uncooled and novel infrared detector materials for night vision and other sensor applications, development of innovative optical and electronic technologies for interconnecting modules in high performance systems, research to realize field portable electronics with reduced power requirements, research addressing affordability and reliability, and research on microelectromechanical systems (MEMS) technology.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Continued investigation of revolutionary approaches to electronics enabled by very small scale devices (nanoelectronics) which operate in a regime where physical phenomenon not important in conventional devices dominate. Demonstrated that compound semiconductor nanoelectronic devices integrated with conventional devices results in significant reductions in chip area required for complex logic functions. Demonstrated the extension of nanoelectronic device designs to silicon-based devices, compatible with future integration with conventional silicon circuits. ($12.3M)
- Demonstrated optical materials and device designs that enable an order of magnitude reduction in threshold current requirements for diode lasers, demonstrated a means for increasing the bandwidth for direct laser modulation by 25%, and demonstrated technology for applying arrays of optical devices for applications in future high-speed, high capacity switching systems. ($4.4M)
- Demonstrated photonic device applications of non-semiconductor thin films doped with optically active ions and explored material technologies for monolithically integrated optoelectronic components. ($3.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project ES-01

- Demonstrated development of high-density integrated electrical/mechanical MEMS along with requisite developments of CAD tools, materials data base, test and characterization methods, and manufacturing processes. ($6.2M)
- Initiated development of uv-blue gallium nitride based LEDs and lasers for high density memory, lightwave countermeasures, convert communications, and warfare. ($5.6M)
- Assessed thermal response characteristics of thin film material for improved sensitivity uncooled infrared detectors. ($.8M)
- Continued low-power electronics program in the area of circuit architecture and power management techniques. Demonstrated Computer Aided Design (CAD) tool for modeling low power circuit designs and estimating circuit static power dissipation. ($5.0M)

(U) <u>FY 1997 Program</u>:

- Continue the nanoelectronics program with emphasis on the following thrusts: combined nanoelectronics and conventional electronics, silicon-based nanoelectronics, chemical self-assembly, and molecular beam epitaxy (MBE) process control and other fabrication techniques. ($11.0M)
  - Demonstrate potential for chemical self-assembled films' use in nanoelectronics.
  - Demonstrate precision process control of semiconductor heterostructures for advanced nanoelectronic devices.
  - Demonstrate improved patterning with critical dimensions below 50 nanometers.
- Demonstrate monolithically integrated optoelectronics for information processing and demonstrate feasibility of three-dimensional optically addressed memory. ($3.4M)
- Fabricate small (5 x 5) infrared sensitive arrays as verification of material properties. ($3.0M)
- Develop and demonstrate efficient low-voltage conversion/distribution circuits and self-regulating, use-driven power allocation systems. ($6.7M)

- Develop and demonstrate uv pulsed laser diode operation in the gallium nitride system. Identify relationship between defect density and applicability to military applications such as uv solar blind detectors for missile threat warning. ($10.0M)
- Continue low-power electronics program in the areas of circuit architecture and power management techniques. Demonstrate 256 X 256 pixel sensor with on-chip 10-bit Analog to Digital Converter (ADC). Demonstrate strategies for non-disruptive power supply switching for reduced power consumption. ($5.6M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project ES-01

(U) FY 1998 Program:

- Optoelectronics - Demonstrate feasibility of using Gallium Nitride detectors as a UV solar-blind detector for missile threat warning and demonstrate UV/blue lasers operating continuous wave for high density memory and chemical/biological detection. ($10.9M)
- Infrared Detector Materials - Determine process for low temperature deposition of thin film uncooled materials. ($3.0M)
- Ultra-Electronics - Demonstrate feasibility of combining resonant tunneling device (RTD) with conventional devices, silicon based quantum MOS technology, and simple quantum cellular automatic logic circuits using silicon and silicon germanium structures. ($11.6M)
- Ultra-Photonics- Demonstrate practical means for implementing high speed optical buffer memories and signal address recognition based on coherent all-optical (photon-echo) technology. Demonstrate the utility of low cost silicon electronic devices doped with optically active elements (such as Erbium) for applications that are now the exclusive domain of more expensive compound semiconductor devices or glassy materials. ($10.6M)
- Low Power Electronics - Complete low-power electronics programs in the areas of circuit architecture and power management techniques. Demonstrate 256 x 256 pixel image sensor with on-chip 10-bit Analog-Digital Converter. ($6.2M)

(U) FY 1999 Program:

- Infrared Detector Materials - Establish feasibility of new uncooled detector structures, including micromachined arrays, thin film ferroelectrics and bolometric materials. ($3.0M)
- Ultra Electronics - Demonstrate programmable matched filter operating at gigahertz speed with substantially less power than silicon complimentary metal oxide semiconductor (Si CMOS), completely integrated molecular beam epitaxy (MBE) growth system which realizes closed-loop control of atomic layer growth and quantum device structures. ($4.9M)
- Ultra-Photonics - Identify the device properties limiting performance of vertical cavity lasers and demonstrate methods for controlling their output beam quality. ($7.7M)
- Advanced Microelectronics - Explore new concepts, directed at demonstrating feasibility of radical device and systems architecture concepts. Of particular emphasis will be device concepts in microelectronics and optoelectronics enabled by technology advances in related areas, particularly those in sub 0.1 micron lithography and mixed-technology integration. ($13.7M)
- Integrate promising new elements of ultra-electronics, high power electronics, non-volatile memory and Electro-Magnetic Interference (EMI) electronics to address current thrusts in smaller, lighter, more mobile information systems and highest performance components and systems. ($12.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 1 Basic Research	Defense Research Sciences, PE 0601101E, Project ES-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	42.6	39.7	40.1	34.4
Appropriated	38.3	N/A	N/A	N/A
Current Budget	37.3	39.7	42.3	41.3

(U) **Change Summary Explanation**:

FY 1996 Decrease reflect minor repricing adjustments.
FY 1998-99 Increase reflects program adjustments.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials Sciences MS-01	17,365	11,700	15,000	17,691	19,622	19,953	21,053	21,053	Continuing	Continuing

(U) **Mission Description**: This project is concerned with the development of: high power density/high energy density mobile and portable power sources (including batteries and fuel cells); forward combat casualty care medical technologies; technologies for defense against biological warfare agents; magneto-resistive materials for use in radiation hardened memories and motion sensors; processing and design approaches for nanoscale and/or biomolecular materials and interfaces; and medical pathogen countermeasures.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Electrochemistry. ($10.6M)
  - Developed and demonstrated a high efficiency fuel reformer for fuel cell applications to process logistic fuel (e.g., DF-2, JP-8).
  - Demonstrated fuel cell operation using either hydrogen or methanol with performance adequate for soldier applications.
  - Tested a novel direct oxidation logistics fuel cell concept.
- Biomedical. ($1.7M)
  - Exploited technology base developments in microelectronics, sensors, communications, imaging and simulation to enhance far-forward combat casualty care. This project provides component and modular additions to the Personnel Status Monitor (PSM) under development in PE 0602712E, project MPT-07.
  - Accelerated development of a Ranger Overwatch personnel status monitor (RO-PSM) with standard PSM configuration and added temperature and shiver sensors to detect hypothermia.
  - Developed haptic interface for virtual environments and holographic display for virtual images in simulation.
- Biological Warfare (BW) Defense. ($3.2M)
  - Developed technology for antibody deposition on chips for real-time BW sensing.
  - Initiated structure-based design of antibody combining site for spore identification.
  - Developed engineering analysis for miniature environmental air sampler to transfer biological materials into fluids.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project MS-01

- Demonstrated the feasibility (in the laboratory) of using human red blood cells and stem cells to eliminate pathogens from the blood for the purpose of potential defense against biological weapons.

• Magnetic Materials and Devices. ($1.9M)
- Enhanced magneto-resistance ratio at low magnetic fields for faster response and higher sensitivity of magnetic devices.
- Evaluated spin transistor and spin tunneling devices for use in sensors and non-volatile memories.

(U) FY 1997 Program:

• Electrochemistry. ($8.6M)
- Develop and test a thermally integrated fuel cell stack and reformer which operates on logistics fuel.
- Demonstrate direct oxidation, liquid-feed methanol fuel cell stack operation with performance adequate for soldier applications.

• Biomedical. ($1.7M)
- Develop miniaturized, conformal design and rechargeable polymer power sources for the Personnel Status Monitor (PSM); augment sensor suite with "sensate liner" intelligent clothing.

• Magnetic Materials and Devices. ($1.4M)
- Fully characterize spin transistor and other spin polarized transport devices for use in ultra-high density memory applications.

(U) FY 1998 Program:

• Electrochemistry. ($11.5M)
- Construct and test a logistics fueled fuel cell power plant for mobile electric power applications.
- Begin component and system study/demonstration of a direct oxidation fuel cell for replacement of military standard batteries.
- Explore alternative sources of energy for portable power applications.
- Develop and demonstrate thermoelectric materials with improved figure of merit.

• Nanoscale/Biomolecular Materials. ($1.5M)
- Exploit recent advances in materials design and processing to demonstrate nanostructural control of materials properties with an emphasis on emulating the complex microstructure and scale of biological materials.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project MS-01

- Pathogen Countermeasures. ($2.0M)
  - Determine one or more mechanisms a stem cell could use to link detection of a pathogen to the production by the cell of vaccines and/or therapeutics.

(U) FY 1999 Program:

- Portable Power. ($11.0M)
  - Optimize catalysts, polymeric membranes, and separator plates for high energy density fuel cell operation.
  - Brassboard testing of compact, high performance energy sources for portable power applications.
  - Demonstrate novel thermoelectric cooling devices based on advanced materials.
- Nanoscale/Biomolecular Materials. ($3.7M)
  - Demonstrate the applicability of nanostructural and/or biomolecular materials in defense applications such as armor, high strength fibers, or coatings.
- Pathogen Countermeasures. ($3.0M)
  - Conduct research into the biochemical pathways at the cellular level to determine which can be blocked to stop virulence pathogens of concern to DoD.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	22.4	11.7	11.5	18.7
Appropriated	18.2	N/A	N/A	N/A
Current Budget	17.4	11.7	15.0	17.7

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects inflation related reductions.
FY 1998 Increase reflects new efforts in nanoscale/biomolecular materials and thermoelectric materials.
FY 1999 Decrease reflects minor program repricing.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology, PE 0602301E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Computing Systems and Communications Technology	**353,692**	**346,957**	**369,690**	**384,147**	**400,855**	**466,092**	**515,481**	**541,827**	**Continuing**	**Continuing**
JASON ST-01	1,163	1,196	1,190	1,200	1,200	1,200	1,200	1,200	Continuing	Continuing
Intelligent Systems & Software ST-11	84,466	98,441	108,050	110,481	110,256	127,007	143,007	147,007	Continuing	Continuing
High Performance Computing ST-19	186,410	191,150	195,029	206,157	218,481	261,411	279,192	297,192	Continuing	Continuing
Software Engineering Technology ST-22	25,519	18,072	19,609	20,196	20,803	21,428	21,428	21,428	Continuing	Continuing
Monitoring Technologies ST-23	27,891	0	0	0	0	0	0	0	0	N/A
Information Survivability ST-24	26,243	38,098	45,812	46,113	50,115	55,046	70,654	75,000	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because it funds projects directed toward the application of advanced, innovative computing systems and communications technologies. These programs include:

(U) DARPA leadership of the Federal High Performance Computing and Communications Initiative to develop technologies that lead to successive generations of more secure, higher performance, and more cost-effective scalable systems critical to defense operations and federal needs.

(U) The efforts funded in the Intelligent Systems and Software project focus on the development of new information processing technology concepts that lead to fundamentally new software and intelligent system capabilities. Emphases

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E

are in intelligent systems including autonomous systems, interactive problem solving, intelligent integration of information, software development, and manufacturing automation and design engineering.

(U) The Software Engineering Technology project supports the Software Engineering Institute (SEI) that works to transition state-of-the-art technology, and introduce and promulgate modern software in the defense industry.

(U) The Monitoring Technologies project provides the technology to collect and fuse surveillance sensor data, with particular focus on those technologies needed by the U.S. to support the Comprehensive Nuclear Test Ban Treaty (CTBT) negotiations which began in 1994, the Non-Proliferation Treaty conference which convened in 1995, and the regimes established to verify these treaties. CTBT verification readiness transfers to Air Force P.E. 0305154F in FY 1997.

(U) The Information Survivability project develops the technology base underlying the solutions to protecting DoD's mission-critical information systems against attack upon or through the supporting infrastructure. These technologies lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites and to high-performance computing technologies.

(U) The JASON Group supports studies for the national security community.

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology, PE 0602301E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
JASON ST-01	1,163	1,196	1,190	1,200	1,200	1,200	1,200	1,200	Continuing	Continuing

(U) **Mission Description:** This project supports the JASONs, an independent group of distinguished scientists and technical researchers that provides analysis of critical National Security issues. JASON membership is carefully balanced to provide a wide spectrum of scientific expertise and technical analysis in theoretical and experimental physics, materials, information sciences, and other allied disciplines. The JASON process ensures senior government leaders have available the full range of U.S. academic expertise on issues critical to National Security involving all classified and unclassified information.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Continued studies in: nuclear and chemical weapons proliferation, precision strike weapons, global surveillance and communications; counter drug surveillance techniques; shallow water ASW; and advanced signal processing.

(U) FY 1997 Program:

- Continue studies in: counter proliferation of chemical and biological weapons; precision deep strike weapons, battlefield information systems, battlefield planning and control, law enforcement surveillance techniques; land mine detection; advanced sensor technologies; and global surveillance and intelligence.

(U) FY 1998 Program:

- Continue studies of interest to DoD in multiple disciplines such as: counter proliferation of chemical and biological weapons; precision deep strike weapons, battlefield information systems, battlefield planning and control, law enforcement surveillance techniques; land mine detection; advanced sensor technologies; and global surveillance and intelligence.

(U) FY 1999 Program:

- Continue studies of interest to DoD.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	1.2	1.2	1.2	1.2
Appropriated	1.2	N/A	N/A	N/A
Current Budget	1.2	1.2	1.2	1.2

(U) **Change Summary Explanation**: No change.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Computing Systems and Communications Technology, PE 0602301E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Intelligent Systems and Software ST-11	86,466	98,441	108,050	110,481	110,256	127,007	143,007	147,007	Continuing	Continuing

(U) **Mission Description:** This project develops new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software systems supporting computer and software intensive defense systems. Major areas of technical emphasis are: (a) intelligent systems (artificial intelligence) including autonomous systems, image understanding, interactive problem solving and intelligent integration of information from heterogeneous sources; (b) software development technology including languages, algorithms, data and object bases, domain specific software architectures, software prototype technology, software design tools, software reuse, and advanced software engineering environments; (c) manufacturing automation and design engineering, including the development of advanced software systems which support sharing of engineering knowledge, advanced product and process design representations, integrated product and process design, software tools for design process management, manufacturing process planning, manufacturing process control and demonstrations; (d) Text Video Speech (TVS) program focuses on the integration and application of emerging language understanding technology for both C4I and Intelligence community needs; and (e) organizing resources to obtain access to multiple systems and decision aids that provide logistical information when and where it is needed.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Demonstrated and evaluated advanced reconnaissance, surveillance, and target acquisition algorithms on unmanned ground vehicle; installed baseline RADIUS Site Monitoring System at National Photographic Interpretation Center; delivered first version image understanding environment. ($10.8M)
- Experimentally evaluated implementations for human-aided machine language translation, document understanding, and robust speech understanding in adverse acoustic conditions. ($8.6M)
- Experimentally evaluated implementations of real-time planning and control algorithms. ($1.8M)
- Evaluated knowledge-based planning and decision aids to support the rapid construction of multiple crisis action plans in an operational exercise. ($9.2M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-11

- Developed new techniques for intelligently locating, filtering, accessing, and integrating information from disparate, heterogenous, distributed information sources and demonstrate the use of those techniques in accessing information for air campaign planners, logistics planners, satellite imagery users, weapon system engineers, and others. ($8.5M)
- Developed new persistent object management technology to enable the distributed, parallel, object oriented databases to handle massive amounts of geospatial and other information. ($3.2M)
- Developed an initial library of knowledge base components to support the creation and maintenance of High Performance Knowledge Bases in military command and control. ($1.8M)
- Developed planning and control algorithms for tasking multiple homogeneous assets in support of small unit operations. ($3.5M)
- Integrated Artificial Intelligence based research technologies with numerical simulations and CAD Models, and demonstrated a three fold reduction in trade-off analysis and collaborative design optimization. ($11.2M)
- Continued the human computer interaction heterogenous testbed product development and insertion. Tested, evaluated, and demonstrated enhancements to the user community. ($6.9M)
- Defined consensus Architecture Description Language and Interactive Architecture Synthesis Tools and initiated development of tools for complex system design. ($4.2M)
- Developed and demonstrated multi-echelon, collaborative logistical support tools that integrate planning, execution, monitoring and decisions support systems to achieve real time logistical reallocation and redeployments within and between commands. ($4.2M)
- Supported software initiatives at the National Applied Software Engineering Center (NASEC), Johnstown. ($9.6M)
- Supported Software Productivity Consortium. ($3.0M)

(U) <u>FY 1997 Program</u>:

- Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities. ($6.3M)
- Experimentally evaluate methods for building information detection filters from text, and baseline topic concept recognition from radio news broadcasts. ($4.9M)
- Evaluate distributed design tools and demonstrate multi-agent systems for capture of collaborative design history. ($14.7M)
- Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding. ($6.4M)

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- Develop knowledge-acquisition tools for planning and decision aids systems. ($10.7M)
- Extend Architecture Description Language for complex systems to include performance and context information. ($15.3M)
- Complete the experimental evaluated prototype implementations to support highly distributed, wide bandwidth information processing applications that require persistent objects. ($1.3M)
- Support software initiatives at the NASEC, Johnstown. ($10.0M)
- Develop new image understanding technologies for image exploitation, automatic population of geospatial databases, and video surveillance and monitoring to enhance battlefield awareness. ($6.4M)
- Develop in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information filtering, accessing, and integration software to enable the dynamic management of massive amounts of battlefield information. ($10.7M)
- Develop a library of knowledge base components, composition tools, and an initial integrated development environment to support the creation and maintenance of High Performance Knowledge Bases in battlefield awareness and military command and control. ($9.8M)
- Complete RADIUS effort. ($2.0M)

(U) FY 1998 Program:

- Integrate several MADE design computation tools to demonstrate robust multi-disciplinary design. Demonstrate a 5X reduction in early design trade-off time by combining qualitative and quantitative models. ($10.5M)
- Develop initial prototypes for multi-language text extraction and audio transcription where performance is baselined against that of human operators. ($7.0M)
- Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities. ($11.4M)
- Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding. ($5.7M)
- Develop in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software. ($12.0M)
- Integrate mixed-initiative planning techniques to exploit human planning abilities. Develop methods for closed-loop management of command-and-control processes in dynamic environments. ($10.9M)
- Demonstrate an evolutionary design for complex software environment rapid construction facilities for robust software and intelligent systems technology prototypes, jointly with the military departments. ($17.0M)
- Support software initiatives at the NASEC, Johnstown. ($10.0M)

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- Continue development, demonstrate, and evaluate of image understanding technologies for image exploitation, automatic population of geospatial database, video surveillance and monitoring, and automatic target recognition to enhance battlefield awareness. ($13.6M)
- Use unified knowledge representations in tools for focused knowledge acquisition, extend learning methods, and add new, high-performance, problem-solving methods to the High Performance Knowledge Base library. ($10.0M)

(U) FY 1999 Program:

- Extend Architecture Description Language for complex systems to include performance and context information. ($17.0M)
- Develop language comprehension technology to provide extraction of content and production of summary information focused on information access, manipulation and creation tasks in order to demonstrate improved readiness for military planning and situation awareness. ($12.0M)
- Develop and demonstrate human/system interaction technology to augment human strengths and compensate for human weakness with emphasis on map based and web based interaction for command and control and planning. ($13.0M)
- Develop and demonstrate fully automatic algorithms to determine the structure of radio and TV news broadcasts in several languages allowing military planners and intelligence analysts to detect and tract emerging topics. ($7.8M)
- Demonstrate a 2X reduction in detailed design by integrating Design Web and Computational Tools for multi-disciplinary optimization. ($12.7M)
- Develop in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software. ($12.0M)
- Integrate most successful new image understanding and automatic target recognition technologies into feasibility demonstrations for UAV image exploitation, battlefield visualization, and video surveillance. Demonstrate and evaluate impact of embedded image understanding technologies on battlefield awareness. ($14.0M)
- Develop adversarial planning tools for countering intelligent foes. Continue close interaction with Rome Labs. ($10.0M)
- Develop and demonstrate a situation assessment knowledge base through reuse of knowledge base components. ($12.0M)

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(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	95.0	98.4	107.5	112.8
Appropriated	95.8	N/A	N/A	N/A
Current Budget	86.5	98.4	108.1	110.5

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects rescission of Natural Language Text Program ($-5.0 million), below threshold reprogramming for the High Performance Knowledge Base Program ($+1.9 million), transfer to the SBIR program element, and inflation savings reductions.
FY 1998 Increase reflects revised program reprioritization.
FY 1998 Decrease reflects revised program reprioritization.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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Computing Systems and Communications Technology, PE 0602301E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
High Performance Computing ST-19	186,409	191,150	195,029	206,157	218,481	261,411	279,192	297,192	Continuing	Continuing

(U) **Mission Description**: This project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future defense and federal needs. These technologies lead to successive generations of more secure, higher performance, and more cost-effective scalable systems associated software technologies, advanced mobile information technology and prototype experimental applications critical to defense operations as well as the federal government. Each component of this program will integrate capabilities developed under the Information Survivability initiative (Project ST-24) to satisfy defense requirements for secure systems.

(U) The Defense Information Enterprise component develops underlying networking systems technology that enables application developers to demonstrate prototype solutions to national and global-scale defense problems. These include network-based information services, application demonstrations, mobile information systems, and experimental capabilities supporting computing systems developmental efforts. The component is strongly supported across other DoD and federal agencies. This program has been reduced in 1996 and beyond to activities associated with defense based global mobile information systems.

(U) The Systems Environments component develops scalable software which is tailored toward easing the use of systems by application programmers. This includes languages, runtime services, scalable software library technologies, and experimental applications.

(U) The Networking component develops high performance networking technologies and associated capabilities. Research is coordinated with network technology and service deployments made by DoD, NASA, and other federal agencies.

(U) The Scalable Systems and Software component develops software and hardware technologies leading to a secure scalable computing and communications technology base for systems configured over a wide performance range, from mobile handheld devices to desktop workstations to the largest-scale, highest performance systems.

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(U) The Microsystems component develops design tools, environments, and design infrastructure to support the research and development of advanced scalable parallel computing components and embedded computing systems. Microsystems is the incubator and delivery mechanism of future generation defense advanced information systems components; delivering the enabling component base to the Scalable Systems and Software and Defense Technology Integration and Infrastructure program areas. Microsystems if the critical bridge that leverages other DARPA technology in low-power processes, advanced packaging, materials, and electronic componentry to develop the critical architecture and building blocks of the most advanced defense computing and communication systems.

(U) Defense Technology Integration and Infrastructure combines state-of-the-art computing and information technologies focused on critical defense applications. These include developing embeddable systems based upon scalable technologies, and projects which accelerate technology transition of advanced research to intelligence, command and control, and other major DARPA and DoD programs.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Global Mobile Information Systems. ($15.9M)
  - Developed initial prototype of adaptive extensions to Internet services in support of mobility.
  - Developed initial prototypes of untethered node hardware/software architectures for mobile computing.
  - Demonstrated design environments supporting simulation and synthesis of wireless systems spanning integrated circuits to network applications.
  - Completed the experimental evaluation of the integration of multiple advanced intelligent systems and software technologies in autonomous applications.
- Systems Environments. ($22.0M)
  - Evaluated first generation of fully scalable operating system software and programming environments on small-scale versions of teraops computing systems.
  - Defined second generation of High Performance Fortran with extensions for task parallelism and support for scalable I/O.
  - Demonstrated extensions of portable scalable libraries to incorporate object-oriented technology and a broader set of applications.
  - Enhanced and experimentally evaluated advanced software environment that supports composition tools for software creation, integration, development, and testing using animation techniques.

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- Networking. ($26.8M)
  - Prototyped networks at greater than 40-gigabit-per-second speed using optical technologies and experimentally validated scalable network protocols at the higher speeds.
  - Prototyped secure nomadic computing architecture integrated into existing wide area networks.
  - Deployed reference implementation of protocol-independent, multicast-capable infrastructure as basis for development of advanced services.
  - Demonstrated robust and secure network-level infrastructure protocols to include directory services and resource allocation.
  - Demonstrated technology for autonomous, node-level network management.
- Scalable Systems and Software. ($37.6M)
  - Demonstrated user-extensible microkernel operating system technology, integrating compiler and run-time support services.
  - Demonstrated computing node architectures that dramatically increase internal memory and communications bandwidths.
  - Demonstrated I/O enhancements to a scalable operating system that overcomes identified bottlenecks leading to significant improvements in throughput.
- Microsystems. ($34.7M)
  - Performed early demonstration of parallel, fully-hierarchical Automatic Test Generation for both combinational and sequential circuits.
  - Demonstrated fault-tolerant and reliability design tools supporting large-scale HPC systems developments.
  - Designed message-passing/shared-memory hybrid architecture protocol accelerator component.
  - Demonstrated distributed computing architectures based on low-cost, low-latency switching technology.
  - Prototyped emulation-enhanced system simulation capabilities for microsystems design.
  - Demonstrated integrated module-level synthesis capability.
  - Developed highest performance open interconnect component for embedded defense systems, future demos in various systems, missiles and satellites.
- Defense Technology Integration and Infrastructure. ($41.4M)
  - Developed and provided experimental testbed services employing advanced high performance computing technologies for defense users.
  - Prototyped embedded computing system modules with scalability concepts containing memory hierarchy and power on a single unit of replication.

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- Performed integration tests in key defense applications such as advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces.
- Demonstrated first fine-grained high performance embedded and scalable computer system.
- Demonstrated graphical program environments for embedded systems.
- Demonstrated prototype toolkits supporting development of applications adaptive to changes in the computing and communication environment.
- Demonstrated prototype of information services through a testbed incorporating information management and secure transactions.
- Developed prototype distributed, object-oriented architecture for scalable, interoperable, multimedia digital library repositories.

• Metacomputers. ($8.0M)
- Established a metacomputing center testbed in the National Capital Region.

(U) FY 1997 Program:

• Global Mobile Information Systems. ($17.6M)
- Demonstrate bandwidth-adaptive multimedia node for mobile computing.
- Demonstrate advanced mobile networking algorithms and protocols.

• Systems Environments. ($17.7M)
- Demonstrate optimizing compilers with 5-to-10 times runtime performance improvement through partial compilation and late optimization during program execution.
- Demonstrate High Performance C++ with extensions for both Data Parallel and Task Parallel exploitation of concurrency.
- Prototype common runtime services reducing burden on individual compiler R&D efforts.
- Provide scalable versions of widely-used commercial engineering software, including finite element analysis, leveraging scalable software library technology available to the defense community.
- Demonstrate feasibility of utilizing advanced software environment that supports composition tools for composing software, integration, and software development and testing using animation techniques in military environment.

• Networking. ($33.7M)
- Demonstrate higher level communication services that coordinate distributed computing resources across the network environment.
- Demonstrate transport protocols for multigigabit networks.

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- Demonstrate systems for coordinating sets of workstations as a single computing system.
- Deploy reference implementation of a common base set of network infrastructure protocols and services necessary for secure and reliable network operation.
- Demonstrate wide-area 40-gigabit-per-second and lab-prototype 100+ gigabit-per-second electro-optical transmission and switching systems.
- Develop advanced multicast-based services to include refinements of collaboration systems and autonomous network processes.
- Active networking protocols and execution environments defined and prototype systems operational.

• Scalable Systems and Software. ($32.8M)
- Demonstrate extensible modular operating system framework supporting real-time, distributed, and limited fault-tolerant scalable computing applications.
- Enable demonstration of high-availability systems scaled in performance to 1 teraflop.
- Demonstrate distributed cluster technology scalable to teraflops.
- Demonstrate advanced object management systems integrated with operating systems and applications to achieve efficient use of memory while enhancing execution speed.
- Demonstrate the prototype of a scalable operating system that incorporates high assurance capabilities for the Information Survivability program.
- Demonstrate distributed shared memory across multiple platforms of differing scales.
- Define virtual machine architecture and application programming interface for adaptive, heterogeneous, distributed computing.
- Define resource models and framework for adaptive, end-to-end quality-of-service negotiation and management.

• Microsystems. ($32.5M)
- Demonstrate first prototype scalable systems components that dynamically adapt to threats, are highly evolvable, and optimized for defense embedded applications such as Automatic Target Recognition (ATR).
- Demonstrate high-level, portable parallel test generation system.
- Develop fully-integrated, parameterized, constraint-driven design libraries.
- Demonstrate initial multisite distributed design research environment for simulation and remote experimentation over the National Information Infrastructure (NII) linking scarce resources to reduce costs of defense system prototyping.
- Demonstrate distributed shared memory components on cluster of workstations enabling lower cost, high-performance computing.

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- Demonstrate fault-tolerant, highly survivable, inter-system interconnect for defense distributed computing applications.

• Defense Technology Integration and Infrastructure. ($56.9M)
- Demonstrate integrating testbed architecture incorporating advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces.
- Demonstrate initial capabilities of intelligent information services architecture with multiple mechanisms for describing resource capabilities and with a uniform interface to hybrid search methods for resource retrieval.
- Demonstrate enhanced feature, real-time distributed operating systems for embeddable HPC.
- Demonstrate 100 gigaops/cu. ft. militarized HPC.
- Develop real-time image understanding algorithms for use in image registration, target recognition, and autonomous navigation for ground level and overhead reconnaissance and surveillance.
- Initial design of collaboration architecture, revealed in specifications for data sharing, coupling and coordination, replication and migration, user interface, real-time services, access and concurrency control, and transcoding generators.
- Demonstrate multi-mode query capability (including natural language speech and text) into distributed digital library repositories, with retrieval of ranked-relevancy multi-media (video, text, voice) information.

(U) <u>FY 1998 Program</u>:

• Global Mobile Information Systems. ($16.9M)
- Demonstrate bandwidth-aware and adaptive computing in context of mobile multimedia conferencing.
- Demonstrate continuous mobility between wireless domains over an interconnected fixed terrestrial network.

• Systems Environments. ($20.0M)
- Demonstrate scalable versions of new solvers for Radar Cross-Section Modeling.
- Address computational bottleneck in engineering software with library of scalable sparse solvers based on approximate factorization.
- Integrate ScalAPACK scalable libraries into High Performance Fortran (HPF) and prototype High Performance C++ languages.
- Demonstrate HPF II supporting task-parallel applications such as Advanced Distributed Simulation.
- Demonstrate High Performance C++ supporting both task and data parallelism.

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- Overcome critical computational barrier to rapid development of electronic systems by demonstrating parallelized compiled switch-level simulation.

• Networking. ($38.0M)
- Demonstrate robust and secure network services and management.
- Demonstrate protocols and routing for extremely large (1 billion node) networks.
- Demonstrate networks that are rapidly deployable and self-configuring.
- Demonstrate high performance (10,000,000 packets/second) routers.
- Complete exploratory work on terabit per second network protocols and hardware.
- Demonstrate robust Active Networking protocols and execution environments.

• Scalable Systems and Software. ($33.0M)
- Distributed (FLASH) SGI T5-based MAGIC system demonstrates hardware-assisted distributed shared memory in cluster environment.
- Prototype demonstration of "converged" parallel virtual multi-parallel processor architecture.
- Scalable system demonstration for high efficient instruction level parallelism.
- Demonstration of auto-parallelization of file I/O from scalable I/O consortium.
- High performance graphics visualization on distributed FLASH.
- First node level demonstrations of ultra-low power systems.
- Novel backplane networks (e.g., split) supporting security.
- Communication overlay supporting high performance I/O on large out-of-core problems.
- First prototype scalable nodes leveraging microsystems architecture optimizations and advanced packaging.
- First demonstrations on scalable nodes providing microarchitecture support for security.
- Commercially-supported operating system available for DoD use with secure evaluated trusted computing base operating systems and servers.
- Feasibility demonstrated of separating the port rights introduced originally by Mach that combined message passing, authority, and authentication into separate components for a more modular approach to computer system security and assurance.
- Prototype extensible operating systems permit fine-grained application-level resource management.

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- Microsystems. ($35.8M)
  - Demonstrate combined verification/simulation techniques to guarantee the integrity and security of defense system hardware components.
  - Optimized VHDL compiler 100x performance on shared memory multiprocessors.
  - Demo symbolic simulation linked with hardware emulation for complex defense system design.
  - Demonstrate scalability beyond 128 nodes of parallel Technological Computer Aided Design (TCAD) design environment on technology examples.
  - Demonstrate scalable computational circuits with low voltage, low power validating TCAD design environment.
  - Demonstrate runtime environments for highly adaptive configurable defense embedded systems.
  - Prototype demonstration of re-configurable architecture.
  - Demonstrate hardware accelerated distributed shared memory on workstation clusters.
  - Demonstrate viability of amorphous and continuum architecture concepts for 100,000-1,000,000 element arrays.
  - Define the limits of interfacing quantum computing to silicon electronics.
  - Demonstrate small-scale system prototypes enabling remote adaptive Information Security (INFOSEC) configuration.
- Defense Technology Integration and Infrastructure. ($40.0M)
  - Demonstrate integrated DoD information architecture and testbed for intelligent resource discovery, adaptive bandwidth allocation and database retrieval.
  - Middleware technology supporting interoperability and reuse across defense embedded applications.
  - Submarine universal beamformer at-sea demonstration.
  - Demonstrate elements of middleware support technology including support for secure transactions, resource discovery, and information retrieval.
  - Changes in Global Command and Control Systems (GCCS) Leading edge design described in the hierarchy of architectures model.
  - Transition management of integration testbed to defense operators.
  - Demonstrate near real-time ingest and indexing of multi-media materials into distributed digital repositories.
  - Demonstrate natural language query and mediator-enhanced query across multiple disciplines to multi-media digital library repositories.

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- Embeddable Systems. ($5.0M)
  - UUV demonstration of two level multicomputer.
- Intelligent Collaboration and Visualization. ($6.3M)
  - Demonstrate design for transcoding generators, indicated by real-time interchange among three collaboration systems, each using a different session control protocol.
  - Demonstrate multimedia archiving and review of sessions using video/audio indexing and synopsizing.

(U) FY 1999 Program:

- Global Mobile Information Systems. ($16.8M)
  - Demonstrate continuous mobility between wireless domains.
  - Demonstrate distributed computing in mobile environment.
  - Demonstrate integrated high data-rate untethered node.
- Systems Environments. ($21.2M)
  - Demonstrate scalable image processing application using DARPA embedded systems platform.
- Networking. ($36.2M)
  - Complete formal security and survivability analysis of active networking.
  - Deploy Active Networks in testbed environment and evaluate security and survivability.
  - Demonstrate robust enhanced network services.
  - Demonstrate adaptive network resource management systems.
  - Demonstrate 100 Gbps network testbeds.
  - Demonstrate Wavelength Division Multiplotting (WDM) overlay on experimental network base.
  - Demonstrate Communication Services for Coordinated Distributed Computing.
- Scalable Systems and Software. ($34.6M)
  - Demonstrate first generation monolithic, multiprocessing nodes.
  - Architecture scalable to 10 TFlops, $3K/GFlop, and 30W/GFlop.
  - Demonstrate scalability from distributed workstation clusters to teraflop supercomputers on the identical technology base.
  - Demonstrate dynamic quality-of-service monitoring and application-level adaptation.
  - Demonstrate adaptive, fault-tolerant, end-to-end resource management on a high performance local area network with heterogeneous nodes.
- Microsystems. ($37.0M)
  - First 21st century microsystems developed through distributed computational prototyping (CP) approach.

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- Parallel design accelerated by 100X compared to previous technical procedures.
- Defense demonstrations of reconfigurable system (10x performance on ATR).
- Demonstrate programmability of amorphous and quantum computing for military classes of problems.
- Deliver the adaptive component base enabling secure, high-performance, fault-tolerant, defense embedded computing.

• Defense Technology Integration and Infrastructure. ($40.0M)
- Prototype integrated infrastructure in place for storing, locating, displaying, metering, and accounting for digital objects.
- Demonstrate dynamic interoperability of manipulable objects across heterogeneous platforms.
- Hierarchy of architectural frameworks and virtual "testbeds of testbeds" infrastructure to facilitate development of "systems of systems" prototyped and evaluated; research library populated with real-time, secure, safe, and fault tolerant componentware derived from scenario experimentation.
- Demonstrate middleware service technology, including support for secure transactions, resource discovery, and information retrieval in joint defense testbeds.
- Demonstrate concept-based automated ingest, indexing, and information retrieval from multi-disciplinary, distributed multi-media digital repositories.

• Embeddable Systems. ($10.0M)
- Prototype Vector/Signal processing reference library.
- Generate synthetic fault tolerant benchmarks.
- Demonstrate node-to-node interoperability standards in JSTARS/BMDO testbed.
- Fabricate intelligent Dynamic Random Access Memory (DRAM) chip.
- Demonstrate wide-area adaptive end-to-end resource management across multiple administrative domains.
- Integrate virtual machine middleware with extensible operating system and active network prototypes for high performance.

• Intelligent Collaboration and Visualization. ($10.4M)
- Demonstrate interoperable collaboration systems based on architecture, shown via joint editing of a document shared among three authors, each using a different document editor.
- Demonstrate collaboration among functionally diverse users operating from a shared semantic model, shown when a single semantic model supports several uses, e.g., simulation, information extraction, and visualization, enabling collaborators to discuss various aspects of the same concepts.

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visualizations.

- Demonstrate and evaluate interoperable asynchronous collaboration among mobile users, revealed through evaluation of a collaborative planning exercise involving nine planners and three different system software environments, where each planner remains disconnected from the others for at least four hours each day during the course of the exercise.

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	234.6	191.2	192.0	208.2
Appropriated	194.4	N/A	N/A	N/A
Current Budget	186.4	191.2	195.0	206.2

(U) **Change Summary Explanation:**

FY 1996 Decrease reflects Bosnia reprogramming action ($-3.3 million), JCS reprogramming action ($-.8 million) and below threshold reprogramming action for SBIR ($-3.9 million).
FY 1998 Increase due to minor repricing adjustment.
FY 1999 Decrease reflects minor program repricing.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Software Engineering Technology ST-22	25,519	18,072	19,609	20,196	20,803	21,428	21,428	21,428	Continuing	Continuing

(U) **Mission Description**: Software is key to meeting DoD's increasing demand for quality, affordability, and timeliness of national defense systems. There is a critical need to rapidly transition state-of-art technology and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems. This project funds the technology transition activities of the Software Engineering Institute (SEI) at Carnegie Mellon University.

(U) The SEI is a DARPA sponsored Federally Funded Research and Development Center (FFRDC). It was established in 1984 as part of the DoD's software initiative to identify high leverage technologies and practices and to establish transition mechanisms that enable technology exploitation by both "in-house" government facilities and the industrial base where the bulk of defense software is produced. The Institute works across government, industry, and academe to: (1) improve current software engineering practice for DoD systems; (2) provide value-added transition of technology to practice; and (3) evaluate and calibrate emerging technologies to determine their potential for improving the evolution of software-intensive DoD systems.

(U) The SEI enables the exploitation of emerging software technology by bringing engineering discipline to software development and evolution. The SEI focuses on software technology areas judged to be of the highest payoff in meeting defense needs. Current focus areas include Trusted Systems and Information Warfare, Software Acquisition Risk Management, Architecture-Centered Software Engineering, and Software Processes and Process Improvement.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Improved practice of software engineering for DoD systems -- validation of Capability Maturity Model (CMM) as guide to effective software process; education in Personal Software Process to improve performance of individual engineers; repository of software risk management experience; guide to current practice of software reengineering; guidelines for adoption of CASE tools; and case studies of product line engineering. ($8.5M)
- Evaluation of software technology to facilitate transition -- guide to software architecture description

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languages; approaches to architecture evaluation and comparison; lessons learned in software technology evaluation; and software process measurement guidebook. ($7.0M)

- Technology focus in trusted software and information warfare -- continued operation of CERT team for network incident responses; SIMPLEX architecture approach to providing safety net for system evolution; quality attribute framework to provide taxonomy for four software quality attributes: safety, performance, dependability, and security. ($1.8M)
- Supported the creation of a software engineering professional structure and broad dissemination of knowledge to the government, industrial, and academic communities. ($3.5M)
- Software managers network effort supported by the development and application of active learning tools for senior level management. ($4.7M)

(U) FY 1997 Program:

- Practice improvement: Integrate and enhance models for software processes, process improvement methods, and analytical capabilities to provide common base for process assessments and improvement analysis. Design and establish repository for DoD software risk management experience that is useful to DoD acquisition managers. ($5.7M)
- Technology evaluation: Expand and improve architecture-centered technologies for product lines and evolutionary systems to develop consensus on guidelines for domain engineering, system reengineering, and open systems. Investigate team approaches to provide improved collaboration capabilities and information dissemination in DoD software development efforts. ($5.1M)
- Trusted software and information warfare: Develop and pilot models for assessing information system survivability. Establish techniques for applying architecture-centered technologies to support the representation and analysis of trust attributes. Study effective countermeasures for information warfare against software-intensive systems including: security risk taxonomy and guidelines, security analysis tool kits, and guidelines for the acquisition of trustworthy open systems. ($7.3M)

(U) FY 1998 Program:

- Improved practice of software engineering for DoD systems -- Automate process support capabilities by providing mechanisms that provide interoperability among heterogeneous design and manufacturing environments. ($1.5M)

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- Evaluation of software technology to facilitate transition -- Evaluate system reengineering approaches that generate secure "wrappers" around legacy code to guarantee desired system properties. Demonstrate and distribute tools to support design of trustworthy systems by relating requirements, technology, and process descriptions. ($6.0M)
- Trusted software and information warfare -- Establish intelligent incident response infrastructure that maintains awareness of current threats and solutions. Provide "immunization" of systems to attack (or other threats) by categorizing the root causes for network security flaws and developing mechanisms to correct these causes. Investigate technology for early analysis of system attributes pertaining to trust based on architectural descriptions of the system. Define and document administrative practices for operating a trustworthy network and distribute on interactive media. ($12.1M)

(U) FY 1999 Program:

- Investigate/develop capabilities for rapid and inexpensive creation of Very High Level Languages (VHLLs) and code generators to attain breakthrough improvements in software productivity and quality. ($3.0M)
- Develop and distribute methods and tools to support prediction of key system properties during system development and preservation during system evolution. ($5.2M)
- Provide tools and techniques to enable rapid adaptation and reconfiguration of systems to ensure survivability in the face of attack. ($3.0M)
- Define effective means for interoperation/integration of heterogeneous system components that are generated from architectural descriptions and account for differences in fidelity and semantics as well as protocols. ($5.0M)
- Establish analysis and test infrastructure for assessing the survivability of software systems that include COTS products. ($4.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	19.2	18.1	19.6	20.2
Appropriated	35.6	N/A	N/A	N/A
Current Budget	25.5	18.1	19.6	20.2

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(U) **Change Summary Explanation**:

FY 1996 Decrease reflects DD-1415 reprogramming of Global Broadcast System ($8.0 million), rescission of Software Managers Network ($1.0 million) and below threshold reprogramming ($1.1 million).

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Monitoring Technologies ST-23	27,891	0	0	0	0	0	0	0	0	103,050

(U) **Mission Description:** This program provides technologies needed by the U.S. to support the Comprehensive Test Ban Treaty (CTBT) negotiations which began in 1994, the Non-Proliferation Treaty conference which convened in 1995, and the regimes established to verify these treaties. This project transfers to Air Force PE 0305154F beginning in FY 1997.

(U) The objective of the CTBT Verification Readiness effort within the Monitoring Technologies Program is to develop and demonstrate new, applied technologies for the detection, location and identification of 1 kiloton nuclear explosions. A major part of this effort is to prototype a CTBT International Data Center (IDC), which is anticipated to become central to both U.S. and international CTBT verification operations. These technologies will also be incorporated into U.S. operational systems. The IDC will have significant responsibilities in the acquisition and management of data submitted by treaty parties and collected during on-site inspections, and in the management of unattended operation of distributed sensors and international communications.

(U) To meet these requirements, DARPA has placed an increased focus on data authentication, automated processing and knowledge acquisition, reliable and secure distributed processing on UNIX systems, advanced data management technologies, effective graphic user interfaces for data visualization and access, and an open and modular system architecture. The IDC will be the centerpiece of a Conference on Disarmament monitoring experiment (called GSETT-3) that started full-scale operations in January 1995. Much of this same system will be used at the U.S. National Data Center for GSETT-3, that will be operated by the Air Force. The U.S. has formally offered the product of DARPA's work to the negotiating body for use by the future international Comprehensive Test Ban Treaty (CTBT) verification organization.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- U.S. CTBT Verification Readiness Program.
  - Expanded full-scale prototype IDC testing with emphasis on expanding automatically the global CTBT data fusion knowledgebase.
    - -- Demonstrated utility of system to accomplish processing of seismic data when needed by International Data System.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-23

-- Demonstrated initial prototype to CTBT negotiations and develop transfer plan to international organization.

- Continued technology transfer to U.S. Air Force and began transfer to international CTBT organization. ($14.6M)
- Completed development and integration of the seismic event identification subsystem, automated seismic signal processing algorithms, global continuous threshold monitoring subsystem, network simulation routines, geographic information visualization, and seismic identification of small events. ($2.5M)
- Developed an industry-based program to accelerate development of nuclear detection systems. ($4.9M)
- Developed an industry-based laboratory for forensic analysis in support of counter terrorism. ($2.9M)
- Developed nuclear sensor data analysis capabilities. ($2.9M)

(U) FY 1997 Program:

- U.S. CTBT Verification Readiness Program.
  - Program transfers to U.S. Air Force in FY 1997, PE 0305154F - Arms Control Implementation for completion and transfer to international CTBT organization and to the U.S. National Data Center.

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	18.9	0	0	0
Appropriated	28.5	N/A	N/A	N/A
Current Budget	27.9	0	0	0

(U) **Change Summary Explanation**:

FY 1996 Decrease due to Bosnia reprogramming action.

(U) **Other Program Funding Summary Cost**: N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-23

(U) **Schedule Profile**: N/A

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology, PE 0602301E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Survivability ST-24	26,243	38,098	45,812	46,113	50,115	55,046	70,654	75,000	Continuing	Continuing

(U) **Mission Description**: This project develops the technology base underlying the solutions to protect DoD's mission-critical information systems against attack upon or through the supporting infrastructure. These technologies lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites and to high performance computing technologies. Technologies developed under this project will be exploited in High Performance Computing (ST-19) and other defense programs to satisfy defense requirements for secure and survivable systems. This program is an expansion of investments in information security made previously in High Performance Computing.

(U) Information Survivability focuses on early prototypes of software and hardware technologies leading to scalable protection for large-scale, heterogeneous systems usable over a wide range of performance in diverse threat environments. High confidence networking technologies will be developed consisting of security mechanisms and value-added security services for integration into network technologies. High confidence computing systems will be developed that provide modular security services and mechanisms, provide high reliability for distributed computations, and allow geographically-separated parts of an organization to interact as if they shared a common security perimeter. This also includes secure and fault-tolerant operating systems, firewalls, and system management tools. Assurance and integration tools will aid the development of high assurance and trusted systems that add expression of modular system structures, networking, and other distributed-system protocols and the ability to reason about their security properties.

(U) Survivability technologies will be developed to mitigate national and defense computing infrastructure vulnerabilities that could be exploited by an information warfare enemy. Intrusion-detection systems will allow attacks on the defense infrastructure to be detected, the damage to be assessed, and appropriate response to be taken. Technologies will be developed to allow crisis-mode operation of critical infrastructure components. Robust networking protocols will be designed to facilitate continuous operations in hostile environments.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-24

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- High Confidence Networking. ($8.2M)
  - Demonstrated prototype of secured routing protocols.
  - Partially developed cryptographic applications programming interface (CAPI) for algorithm independence and ease of integration of security into applications.
- High Confidence Computing Systems. ($10.2M)
  - Demonstrated cryptographic-applications programming interface to allow secure applications to be built independent of the cryptography used.
  - Demonstrated high-assurance microkernel for use in secure operating systems.
- Assurance and Integration. ($3.8M)
  - Begun work on dynamic security metrics and evaluation tool for white-box evaluation of security of systems with respect to a threat model.
- Survivability of Large Scale Systems. ($4.0M)
  - Begun work on verified robust secure multicast protocols able to tolerate Trojan horses and malicious code.
  - Completed initial intrusion-detection prototype.

(U) FY 1997 Program:

- High Confidence Networking. ($10.1M)
  - Demonstrate cryptographic applications programming interface (CAPI)-conformant security services to support electronic commerce and other applications.
  - Integrate basic security services into critical networking protocols for enhanced infrastructure protection.
- High Confidence Computing Systems. ($12.1M)
  - Develop services for defining and enforcing configurable security policies in secure operating systems.
  - Demonstrate increased penetration resistance of firewalls and secure dynamic enclaves by using domain isolation and policy-aware authentication.
- Assurance and Integration. ($7.1M)
  - Demonstrate a tool for secure refinement of secure software architectures.
- Survivability and Vulnerabilities. ($8.8M)
  - Develop limited traceback capability for intrusion-detection systems.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-24

- Demonstrate verified high-availability networking protocols that can tolerate network partitions.

(U) FY 1998 Program:

- High Confidence Networking. ($9.2M)
  - Demonstrate interoperability of network security services across different key management domains.
  - Develop a library of basic security services for embedding in applications.
  - Demonstrate robust networking protocols to allow detection and tolerance of malicious faults.
  - Develop partitionable network services.
  - Transition incident response to self-supporting activity.
  - Demonstrate ability of intrusion-detection systems to cooperate with each other to detect large-scale suspicious patterns.
- High Confidence Computing Systems. ($12.6M)
  - Develop high-assurance firewalls with support for distributed enclaves.
  - Develop tools for assessing damage from attacks.
  - Develop cost-effective techniques for tolerating malicious faults.
  - Develop techniques for recovery and reconfigurability in fault-tolerant distributed systems.
  - Develop techniques for permitting real-time trade-offs between security, reliability, and real-time.
- Assurance and Integration. ($8.4M)
  - Develop formal techniques for reasoning about the security properties of systems expressed in the languages developed earlier.
  - Develop formal techniques for reasoning about robustness properties.
  - Develop evaluation techniques for assessing a system against the metrics defined earlier.
- Survivability and Vulnerabilities. ($15.6M)
  - Develop techniques to allow planned degraded modes of operation for very large-scale systems that ensure a minimum level of service to critical nodes during times of suspected attack.
  - Incorporate COTS products and tools within system approaches to assure acceptable performance during times of suspected attack.

(U) FY 1999 Program:

- High Confidence Networking. ($12.0M)
  - Demonstrate suite of secure reliable distributed applications over mobile and wireless networks.
- High Confidence Computing Systems. ($12.1M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-24

- Demonstrate techniques for general pairwise tradeoffs among fault-tolerant, real-time and security applications.

- Assurance and Integration. ($7.0M)
  - Characterize a set of security and fault-tolerance techniques by strength and cost, for plug and play in wrappers.
  - Demonstrate integration of security composition techniques into software engineering tools.
- Survivability and Vulnerabilities. ($15.0M)
  - Demonstrate Adaptive Architecture for Survivable System of Systems.
  - Develop techniques for diagnosing multi-agent multi-staged attack.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	35.0	38.1	45.5	44.0
Appropriated	27.8	N/A	N/A	N/A
Current Budget	28.2	38.1	45.8	46.1

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects program repricing and transfer of SBIR funds to a separate program element.
FY 1998-99 Increase reflects program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Tactical Technology,
PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tactical Technology	**125,702**	**117,944**	**162,279**	**202,083**	**211,119**	**234,397**	**282,586**	**296,786**	**Continuing**	**Continuing**
Naval Warfare Technology TT-03	39,191	32,639	29,841	38,000	58,553	59,172	79,172	89,172	Continuing	Continuing
Advanced Land Systems Technology TT-04	35,780	22,125	28,000	41,000	44,909	59,686	75,686	69,886	Continuing	Continuing
Advanced Targeting Technology TT-05	7,000	0	0	0	0	0	0	0	0	N/A
Advanced Tactical Technology TT-06	37,403	45,995	60,753	61,418	57,024	62,728	72,728	82,728	Continuing	Continuing
AeronauticsTechnogy TT-07	0	0	20,000	40,000	40,000	42,811	45,000	55,000	Continuing	Continuing
Advanced Logistics TT-10	6,328	17,185	23,685	21,665	10,633	10,000	10,000	0	0	N/A

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because it supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The Tactical Technology program element funds a number of projects in the areas of Naval Warfare, Advanced Land Systems, Advanced Tactical, Aeronautics, and Advanced Logistics technologies.

(U) The Naval Warfare Technology project is focusing on: Simulation Based Design (SBD) and Command, Control, Communications and Intelligence/Synthetic Environments (C3I/SE). The Simulation Based Design program will provide the tools required to integrate cost, performance and manufacturing considerations throughout the design process. The SBD program is developing and demonstrating a prototype infrastructure that will enable a significant positive change in the acquisition process for large, complex warfighting systems utilizing virtual prototypes in synthetic environments. In the C3I/SE program, advanced information technologies are being integrated into advanced prototype systems to provide improved battlefield awareness and dominance to mobile command centers in the field.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E

Ship Systems Automation, a program to develop a highly integrated sensor, weapons control, and battle damage suite to reduce costly shipboard manning requirements, is budgeted to complete in FY 1997.

(U) The Advanced Land Systems Technology project continues efforts in Small Low-cost Interceptor Devices (SLID) and unexploded ordnance detection effort; and initiates robotics for Urban Warfare and Virtual Strike Force deception systems. The SLID program will develop and test a system for providing protection against missiles and projectiles with explosive warheads. The unexploded ordnance program is developing tools such as enhanced sensors, communications upgrades, and new techniques to detect and neutralize mines and other ordnance for use in domestic situations, peacekeeping operations, and low intensity conflicts. Robotics for Urban Warfare will develop and demonstrate small, agile, unmanned systems for use in constrained urban environments. The Virtual Strike Force will provide deception capabilities to draw enemy weapons off target and defeat surveillance sensors.

(U) The Advanced Tactical Technology project is exploring the application of compact lasers, microwave radiation and advanced mathematical algorithms to enhance the performance of radars, sensors, communications, and electronic warfare and target recognition systems. The technologies under development will improve infrared countermeasures, enable active infrared suppression, permit faster signal processing, improve target recognition, and create smaller, more capable microwave devices. Also included in this project is the Miniature Air Launched Decoy ACTD.

(U) Three new starts are budgeted in the Aeronautics Technology project: the Micro Aerial Vehicle, the UAV Guided Parafoil for Logistics, and the Autonomous Inspection and Continuous Built-In Test (ACBIT) program. The micro aerial vehicle will be an order of magnitude smaller than any operational UAV and will be useful in a wide variety of military missions from covert imaging and chemical/biological agent detection to communication enhancement. Leveraging technologies developed in the Small Engine Application Program and Global Positioning System, the Unmanned Aerial Vehicle Guided Parafoil for Logistics will enable rapid resupply of forward deployed forces. Finally, the ACBIT will exploit intelligent miniature sensors to assess the condition of a number of aircraft subsystems, reducing, pre-and-post operation inspections and highlighting maintenance requirements.

(U) Finally, the Advanced Logistics project will develop and demonstrate technologies that will make a fundamental difference in transportation and logistics planning and operations in the 21st Century. Developmental efforts will focus on transportation models and simulations and revolutionary changes to physical systems that impact intermodal system performance and efficiency.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Naval Warfare Technology TT-03	39,191	32,639	29,841	38,000	58,553	59,172	79,172	89,172	Continuing	Continuing

(U) **Mission Description:** The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. The enabling technologies include: virtual prototyping and advanced modeling to radically change the DoD acquisition process through integrated product and process design; integrated ship sensor, weapons and platform technologies to demonstrate the feasibility of reduced ship manning; and Command, Control, Communications, and Intelligence/Synthetic Environments (C3I/SE) for littoral warfare.

(U) The Simulation-Based Design (SBD) area is developing and demonstrating a prototype infrastructure that will enable a significant positive change in the acquisition process for large, complex warfighting systems. SBD will utilize virtual prototypes in synthetic environments to enable effective, integrated product and process development. The program will integrate the technologies of distributed interactive simulation, physics-based modeling, and virtual environments and apply them to the design, acquisition, and life cycle support processes of systems. Complete simulation from early in the concept formulation stage through verification of requirements to design, manufacture, operation, training, and logistics will be available prior to initiation of construction. Successful development and deployment of SBD will enable meeting the program's objective of reducing the cost and acquisition time for DoD systems. Overall product quality and capabilities will be enhanced by the timely insertion of the latest technological advances into designs as they progress through the shortened acquisition cycle. SBD will be applicable to a broad range of system domains including land vehicles, aircraft, satellites and marine vehicles. SBD will be applicable to all subsystems, from mechanical to large scale electronic, within an overall system and it will enable cost savings by reducing the need for expensive physical mockups and by eliminating many of the manufacturing inefficiencies caused by inadequate design.

(U) In the Ship Systems Automation (SSA) area, advanced, highly automated sensor, weapons control, and platform systems (including damage control) are being developed and demonstrated for submarine and surface ship applications. Through evolving sequential technology demonstrations, efforts in this area will show how an integrated collection of automated systems could achieve an order of magnitude reduction in crew size. Because personnel account for a significant portion of current ships' life cycle costs, such a reduction would lead to immediate and long term cost savings for ship acquisition programs. SSA technology developments include intelligent command-level advanced reasoning components, scalable sensor integration work stations to fuse multi-source data and intelligently display the tactical scene on a situation assessment system, cooperating expert agents conducting mission-context/sensor

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employment planning, and integrated internal condition sensor and control systems to intelligently display and control ship physical conditions on a ship's internal assessment system.

(U) In the Command, Control, Communication, and Intelligence/Synthetic Environment (C3I/SE) area, advanced information technologies are being integrated and applied to provide improved battlefield awareness and battlefield dominance to mobile command centers in the field (e.g., Force Commanders, Commander Joint Task Force (CJTF), and deployed Joint Special Operations Task Force (JSOTF) Commanders). The advanced prototype systems developed under this program integrate the latest technologies in high-bandwidth communications, object oriented information system, collaborative planning, intelligent database access, image processing, data exploitation, and high performance computing to address the unique (quick reaction and real-time execution) requirements of forward deployed, mobile commanders. This program also will develop, demonstrate, and transition the tools and systems necessary to recognize, understand, forecast, and develop options to defuse potential crisis situations in hours by reducing the time to form teams, analyze crisis data, and develop and brief options for response. It also develops the Synthetic Test Range (STR), which in conjunction with the Simulation Based Design (SBD) development, is aimed at improving the acquisition process. The STR will conclude in FY 1996 and transition to Naval Sea Systems Command. The C3I/SE Program builds upon existing DARPA-developed planning tools while identifying and incorporating other emerging C3I and information system technologies. Starting in FY 1996, the program is emphasizing collaborative crisis understanding and mitigation developing tools and systems necessary to recognize, understand, forecast, and defuse potential crisis situations. This effort will be focused on National Command Authority, National Security Council, and National Military Command Center.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Conducted Simulation-Based Design (SBD) prototype demonstrations on a complex ship application at distributed design and visualization centers linked via nationwide networks; the first a joint demonstration in support of the Defense Modeling and Simulation Office High Level Architecture; the second a virtual prototype of a ship combat system using an electronic smart product model to demonstrate functional requirements. ($10.0M)
- Initiated expansion of SBD through application to development programs for small rapid satellite manufacturing, selected aircraft sub-system manufacturing, land vehicle power train design, and ship manufacturing enterprise. ($4.9M)
- Conducted high fidelity radar simulation with an operational radar system, transitioned to Navy users. ($1.8M)

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- Initiated collaborative crisis understanding and mitigation effort, developed concept of operations and visualization demonstration emphasizing data mining, modeling and collaboration in response to pre-crisis indicators. ($1.7M)
- Conducted demonstration and testing of campaign operations planning system applied to joint forces command and control in a deployable package. ($3.9M)
- Demonstrated advanced Ship Systems Automation (SSA) technologies which enable a few operators to collaborate with advanced-reasoning systems to manage the construction of a complex multi-warfare, multi-sensor fusion tactical scene and the effective operation of a combatant ship in that scene. Intelligent System Interface and advanced sensors technologies will continue to be developed and demonstrated. ($10.0M)
- Continued most promising ocean sciences efforts at the Center of Excellence for Research in Ocean Sciences (CEROS). Issued a Broad Agency Announcement and selected several innovative marine technology projects for initiation. ($6.9M)

(U) FY 1997 Program:

- Conduct interim Simulation-Based Design (SBD) prototype engineering demonstration tests of multi-disciplinary engineering analysis for an advanced maritime application. ($8.0M)
- Initiate SBD prototype engineering tests of the smart product model in support of integrated life cycle requirements and analyses of an evolving maritime application. ($3.0M)
- Commence deliveries and support of prototype and interim SBD software to DoD Service's beta sites for use, evaluation, and feedback. ($4.4M)
- Conduct an advanced reasoning systems land-based demonstration in which all Ship Systems Automation (SSA) operator/associate pairs work with a few operators to monitor and control all conditions within the ship (including damaged response) and to fight effectively in a complex tactical scenario. ($9.5M)
- Initiate the development of a software system for collaboratively constructing quantifiable crisis and an "intelligent agent" which can browse across dissimilar, existing databases. ($7.7M)

(U) FY 1998 Program:

- Conduct SBD prototype engineering tests of a large scale smart product model in support of integrated life cycle requirements and analyses of an evolving maritime application. ($12.3M)
- Deliver and support of prototype and interim SBD software to DoD Service's beta sites for use, evaluation, and feedback. ($5.0M)
- Continue systems development and initiate development of a tool for rapid, collaborative plan development, evaluation, and briefing; demo and evaluate retrieval agents; demo use of access templates and profiles;

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evaluate filters. Demonstrate the ability to navigate several of the most important, crisis-related databases for acquiring information on a simulated crisis. ($5.4M)

- Evaluate ability to quantify centers-of-gravity and pressure points for plan development, and demonstrate modeling capabilities at JTF ATD/GCCS LES Insertions. Demonstrate crisis briefing capability for prioritizing policy and plans at NSC/NMCC and supporting intelligence agencies. ($7.1M)

(U) FY 1999 Program:

- Conduct SBD prototype engineering tests incorporating a large scale smart product model on a wide area, wide bandwidth collaboration network with emphasis on near real time optimized ship design changes resulting from analyses of the virtual prototype in a complex synthetic operating environment. ($16.0M)
- Delivery and support of prototype and interim SBD software to DoD Service's beta sites for use, evaluation, and feedback. ($6.0M)
- Demonstrate initial operational capability of the data retrieval and visualization capability, initial operational capability of the crisis modeling capability, and begin installation of modeling capability and integration with data retrieval capability at CIA/NMJIC. Begin installation and integration of advanced briefing capability at CIA/NMJIC. ($16.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	39.5	32.6	24.8	33.0
Appropriated	39.2	N/A	N/A	N/A
Current Budget	39.2	32.6	29.8	38.0

(U) **Change Summary Explanation**:

FY 1998-99 Increase reflects minor program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Tactical Technology, PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Land Systems Technology TT-04	35,780	22,125	28,000	41,000	44,909	59,686	75,686	69,886	Continuing	Continuing

(U) **Mission Description:** This project is intended to develop technologies for contingency missions and military Operations-Other-Than-War (OOTW) to make U.S. combat forces more deployable, effective, survivable, and affordable. This project supports seven main efforts: Robotics for Urban Warfare; OOTW and OOTW/Law Enforcement; Small Unit Operations; Virtual Strike Force to Draw Fire; Small Low-Cost Interceptor Device (SLID); a Foreign Cooperative Demonstration; and Unexploded Ordnance Detection.

(U) The Robotics for Urban Warfare program will develop and demonstrate technology required for the operation of small, agile, extremely capable unmanned systems to support military forces in the highly constrained, unstructured environments characteristic of urban areas. The program will emphasize enhanced mobility through innovative locomotion and manipulation concepts, total immersion telepresence human interface, and the development of an intelligent system architecture required for enhanced autonomy.

(U) Military Operations-Other-Than-War (OOTW) encompass a wide range of activities where military power is used for purposes other than large scale combat. The purpose of the DARPA OOTW research and development program is to develop and demonstrate technologies that will enhance the survivability of individual soldiers and military units engaged in OOTW. These technologies have application to both general military operations and civilian law enforcement. Technology developments are being conducted in areas such as personnel armor; limited effects technology; concealed weapons detection; and automatic language interpretation/translation. Funding for this program will be completed in FY 1996.

(U) The Small Unit Operations (SUO) program will develop the key technologies to enable more capable, dispersed military units to effectively perform warfighting operations traditionally accomplished with larger, massed forces. The SUO program focuses on enabling comprehensive awareness at the tactical level in restrictive environments. Sniper/mortar detection, hyperspectral infrared mine detection, and thru-wall detection work initiated under the OOTW

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program will be continued with an emphasis on small unit operations. In FY 1997, these SUO efforts were realigned into Project EE-51.

(U) The Virtual Strike Force (VSF) program will enhance the effectiveness of small units by offering enemy surveillance sensors alternative targets possessing strong signatures with characteristics appropriate for the intended target. Two thrusts will be pursued to provide a viable demonstration system: (1) develop a low cost signature generator capable of radiating multi-spectral (Infrared, visual, radio frequency) signatures anticipated by surveillance sensors; and (2) provide the ability to rapidly quantify the required signature characteristics to be presented to surveillance opposing forces under dynamic conditions.

(U) The Small Low-cost Interceptor Device (SLID) program will develop and test a system for providing protection against missiles and projectiles with explosive warheads. This system will detect, track and intercept these threats at a standoff distance sufficient to render them ineffective. Applications for the SLID system include: self-defense of vehicles; high value fixed sites such as command centers, parked aircraft and radars; and may be extended to naval platforms and low-speed aircraft.

(U) The Foreign Cooperative Demonstration program will fabricate and demonstrate a new system for enhancing the survivability of armored vehicles based on technology developed by a foreign source.

(U) The Unexploded Ordnance (UXO) Detection program will develop sensors for the chemically specific detection of explosives or other chemicals characteristic of land mines and/or shallowly buried UXO. The sensors developed under this program will provide soldiers with the effectiveness of canine olfaction detection without the logistics and other constraints imposed by the use of live animals. These chemically specific sensors will work either singly or in conjunction with other technologies (such as the hyperspectral mine detector, developed under SUO) that exploit different physical features. As the ultimate goal is not simply detection, but removal of the threat posed by a land mine or UXO, this program also seeks to develop neutralization techniques that will significantly reduce risk and resource requirements.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Operations-Other-Than-War (OOTW) ($7.4M):
  - Completed the Soldier 911 demonstrations in Korea and Macedonia, and the Korean/English text translator.

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- Completed modular tag concept definition phase.
- Continued mine/unexploded ordnance detection technology development, including chemically-specific detection techniques.
- Demonstrated the Korean/English speech translator, the concealed weapons system, extremity armor, and limited effects technology.

• Continued development of sniper, mortar, hyperspectral infrared mine, and thru-wall detection technologies with emphasis on small unit operations. ($13.1M)
• Initiated SLID phase II fabrication and testing effort with remaining contractors. Perform sub-system tests leading to static system tests. ($13.2M)
• Initiated development of the system for the Foreign Cooperative Demonstration. ($2.1M)

(U) FY 1997 Program:
• Continue Small Low-Cost Interceptor Device (SLID) phase II effort. Conduct full system static tests and tests against slowly moving targets. Prepare for live-on-live tests. ($12.1M)
• Complete the Foreign Cooperative Demonstration testing and transition program to the Army. ($2.0M)
• Continue chemically-specific unexploded ordnance/mine detection technology development. Characterize explosive and other related chemical contamination at minefield. Evaluate advanced algorithms and sensor fusion capablities for multiple-sensor detection. Proof-of-concept testing for UXO neutralization techniques. ($8.0M)

(U) FY 1998 Program:
• Initiate development of advanced locomotion concept for small urban warfare robotic platforms and initiate definition and development of intelligent system architecture. ($4.0M)
• Design Virtual Strike Force (to Draw Fire for Small Unit Opeations (SUO) Targeting) system to rapidly quantify and evaluate signature characteristics. Initiate development of multi-spectral signature generator. ($5.0M)
• Complete live-on-live SLID testing, transition to Army. ($7.0M)
• Field demonstration of laboratory scale system for chemically specific detection of land mines. Laboratory demonstration of neutralization techniques. ($12.0M)

(U) FY 1999 Program:
• Demonstrate a small, highly mobile robotic platform suitable for bunker penetration thru small diameter openings, and reconnaissance activities under urban warfare conditions. ($9.0M)

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- Continue development of virtual strike force technology to evaluate multi-spectral signatures. ($12.0M)
- Field demonstration of prototype chemically specific land mine detector paired with other sensors as appropriate. Additional testing of most-promising neutralizaton techniques. ($20.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	34.1	22.1	19.0	30.0
Appropriated	33.2	N/A	N/A	N/A
Current Budget	35.8	22.1	28.0	41.0

(U) **Change Summary Explanation**:

FY 1996 Increase reflects initiation of a Foreign Cooperative Demonstration Program ($+2.1 million) and minor repricing ($+.5 million).

FY 1998-99 Reflects addition of Robotics for Urban Warfare and Virtual Strike Force new starts.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Tactical Technology,
PE 0602702E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Targeting Technology TT-05	7,000	0	0	0	0	0	0	0	0	308,441

(U) **Mission Description:** An improved capability to perform diagnostic analysis of multiple objects with high resolution tracking is required for emerging submunition dispensers and interceptor devices. The Multiple Object Tracking (MOTSS) program will fabricate and test an instrument for analyzing ballistic events with the capability to simultaneously track 20 objects at resolutions of a few centimeters at ranges of 1-to-5 kilometers.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- The Multiple Object Tracking Sensor System has been contracted for delivery in 1997. ($7.0M)

(U) FY 1997-99 Programs: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0	0
Appropriated	7.0	N/A	N/A	N/A
Current Budget	7.0	0	0	0

(U) **Other Program Funding Summary Cost**: N/A

(U) **Change Summary Explanation**: N/A

(U) **Schedule Profile**: N/A

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RDT&E, Defensewide BA 2 Applied Research	Tactical Technology, PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Tactical Technology TT-06	37,403	45,995	60,753	61,418	57,024	62,728	72,728	82,728	Continuing	Continuing

(U) **Mission Description:** This project focuses on the technology and applications of: compact lasers, microwave radiation sources, advanced displays, and mathematical algorithms for signal and image processing and modeling and simulation of nonlinear processes to dramatically improve the performance of radar, sensors, and systems for electronic warfare, target recognition, and military communications. Seven broad technology areas are being investigated: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasures, laser radar and sensors; (b) miniature air-launched decoy systems; (c) compact high density data storage for high bandwidth image processing; (d) fast computational algorithms for signal processing, target recognition and tracking, electromagnetic and acoustic propagation in nonlinear media, materials, and microelectronics processing; (e) passive infrared signature suppression to counter air-to-air missile threats; (f) precision optics components for critical DoD applications; and (g) tactical landing systems.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Compact Lasers. ($7.3M)
  - Demonstrated compact lasers and active tracking systems at mid-infrared wavelengths for infrared (IR) countermeasures.
  - Demonstrated mid-infrared lasers, packaged for slow motion, dynamic testing.
  - Demonstrated and tested a compact active tracking system brassboard for mid-infrared wavelengths.
- Holographic Data Storage. ($5.9M)
  - Performed technology demonstration to establish system trade-offs of various candidate materials for holographic data storage.
  - Demonstrated proof-of-principle digital holographic data storage devices to establish the capability of various multiplexing methods and error detection and correction schemes.
- Fast Computational Algorithms. ($13.3M)
  - Demonstrated wavelet-based methods for automatic target detection and recognition.
  - Demonstrated multiresolution methods and adaptive waveforms for image formation and processing.
  - Developed hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of both wavelets and nonlinear partial differential equation-based methods.

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- Developed 3D implementation of fast multipole method for radar cross section calculations.
- Identified approaches to reducing high-order nonlinear descriptions of thin film processes to real-time sensing and control models.

• Precision Optics Technology. ($3.1M)
- Developed conformal and off-axis optical components for next generation tactical systems using computer-aided design and manufacturing.

• Advanced Infrared Signature Suppression. ($.9M)
- Integrated and demonstrated (flight test) a long-wave infrared (LWIR) suppression system.

• Tactical Landing System (TLS). ($6.2M)
- Fabricated and demonstrated a transportable TLS designed for minimal installation/calibration times; accuracy improved through the addition of a phase measurement capability; integrity monitoring feature added to permit autonomous operations.

• Miniature Air-Launched Decoy. ($.7M)
- Conducted engine independent validation and establish system design.

(U) <u>FY 1997 Program</u>:

• Compact Lasers. ($6.7M)
- Demonstrate breadboard systems of compact high power tunable mid-infrared lasers, and laser diodes operating at mid-infrared wavelengths.
- Demonstrate breadboard tunable mid-infrared lasers with 20 watt output power at 20 kilohertz (KHz) pulse repetition rate for ship defense.
- Demonstrate room temperature operation of mid-infrared laser diodes.

• Holographic Data Storage. ($4.9M)
- Technology demonstration to establish functional limits of holographic data storage.
- Demonstrate 1 terabit storage capacity for functional evaluation of write once and read many type storage systems.

• Fast Computational Algorithms. ($24.2M)
- Continue development and transition of novel algorithms for automatic target recognition and image processing and develop associated electromagnetic and acoustic propagation models.
- Begin development of models of thin film processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
- Select automatic target recognition algorithms for system insertion demonstrations.
- Apply adaptive waveform designs to radar and communication.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-06

- Implement a hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of wavelets and nonlinear partial differential equation-based methods.
- Demonstrate orders-of-magnitude speed-up provided by parallel implementation of fast multipole techniques to radar cross section calculations.
- Develop methods for calculating electromagnetic scattering from objects in ground clutter.
- Develop process, sensing, and control models based on fundamental principles for thin film vapor deposition processes.

• Precision Optics Technology. ($7.0M)
- Continue development of conformal and off-axis optical components for tactical systems.
- Develop magneto-rheological finishing for aspheres, toroids and cylinders.
- Demonstrate near net shape conformal window fabrication.

• Miniature Air-Launched Decoy (MALD). ($3.2M)
- Begin MALD system design, engineering and producibility analysis. Design fabrication and qualification testing of subsystem and seek eagle.

(U) <u>FY 1998 Program</u>:

• Compact Lasers. ($4.0M)
- Demonstrate compact high power tunable lasers and laser diodes at mid-infrared wavelengths.
- Develop breadboard tunable mid-infrared lasers for airborne infrared countermeasures.
- Demonstrate room temperature long wavelength laser diodes in the 7-to-9 micrometer wavelength range.

• Holographic data storage. ($1.0M)
- Demonstrate 1 terabit storage capacity for functional evaluation of read/erase type storage systems.

• Precision Optics Technology. ($14.5M)
- Continue development of conformal optical system components for tactical systems.
- Complete designs of conformal optics sensor systems for airborne platforms and missiles.
- Fabricate aspheric optical components and diffractive optical elements on curved substrates.
- Demonstrate metrology tools.

• Fast Computational Algorithms. ($25.1M)
- Continue development and transition of novel algorithms for automatic target recognition and signal/image processing, as well as development of associated electromagnetic and acoustic propagation scattering models.
- Continue model development for thin film processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.

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- Demonstrate hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of wavelets and nonlinear partial differential equation-based methods.
- Develop system-specific wavelet-based automatic target recognition algorithms.
- Develop prototype electromagnetic scattering models for objects in ground clutter.
- Develop simulation codes for thin film processing, sensing, and control.
- Develop mathematical approaches to developing optimal portable applications libraries for selected computational kernels required in thin film process simulations.
- Demonstrate toolboxes for generating optimal portable Fast Fourier Transforms and wavelet algorithms and apply to high dimensional synthetic aperture radar.

• Miniature Air-Launched Decoy (MALD). ($16.2M)
- System integration and flight demonstration and continue Seek Eagle process.

(U) FY 1999 Program:

• Compact Lasers. ($5.8M)
- Complete demonstration of compact high power tunable lasers and laser diodes at mid-infrared wavelengths.
- Develop packaged tunable mid-infrared lasers for airborne infrared countermeasures.
- Demonstrate laser diode arrays operating at mid-infrared wavelengths.

• Fast Computational Algorithms. ($31.1M)
- Continue development and transition of novel algorithms for automatic target recognition and signal/image processing, as well as development of associated electromagnetic and acoustic propagation scattering models.
- Continue model development for thin film processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
- Demonstrate system-specific wavelet-based automatic target recognition algorithms.
- Validate prototype electromagnetic scattering models for objects in ground clutter.
- Validate models of thin film processing, sensing, and control systems.
- Develop prototype toolboxes for generating optimal portable applications libraries for selected computational kernels required in thin film process simulations.

• Precision Optics Technology. ($10.0M)
- Continue development of conformal optical system components for tactical systems.
- Near net-shape growth of conformal windows.
- Laboratory assembly and demonstration of conformal sensor systems for airborne platforms and missiles.

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- Miniature Air-Launched Decoy (MALD). ($14.5M)
  - Continue system integration, Green Flag demonstration, acquire flight certification and transition to Service.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	39.4	46.0	50.6	56.4
Appropriated	39.5	N/A	N/A	N/A
Current Budget	37.4	46.0	60.8	61.4

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects initiation of Virtual Integrated Prototyping, ($+1.5 million); offset by Bosnia reprogramming action ($-2.4 million) and reprogramming of SBIR funds to PE 0605502E ($-1.2 million).

FY 1998-99 Increase due to outyear funding for the Virtual Integrated Prototyping program.

(U) **Other Program Funding Summary Cost**:

	FY 1996	FY 1997	FY 1998	FY 1999
Funding for Miniature Air-Launched Decoy PE 0603757D, Advanced Concept Technology Demonstration.	0.5	4.7	0.0	0.0

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RDT&E, Defensewide BA 2 Applied Research	Tactical Technology, PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Aeronautics Technology TT-07	0	0	20,000	40,000	40,000	42,811	45,000	55,000	Continuing	Continuing

(U) **Mission Description:** Aeronautics Technology efforts will address high payoff opportunities to dramatically reduce costs associated with advanced aeronautical systems or provide revolutionary new system capabilities for satisfying current and projected military mission requirements.

(U) The Autonomous Inspection and Continuous Built-in-Test (ACBIT) program will dramatically lower costs of pre- and post-flight maintenance and inspection of military aircraft - a significant contributor to aircraft operations and support budgets. Emerging technologies provide the potential to design, develop and demonstrate an advanced autonomous inspection, continuous built in test (BIT) architecture. The planned system will use a fiber optic token ring, data retrieval scheme that exploits intelligent, miniaturized sensors to monitor and assess such critical components as seals, hinges, pins, and fluids as well as subsystem performance. This in-situ system will greatly alter both the concepts and practices of periodic and scheduled maintenance by preventing properly functioning components from being removed for visual inspection unnecessarily and by allowing malfunctioning components to be detected and isolated immediately.

(U) A new family of Micro-Aerial Vehicles (µAV) which are at least an order of magnitude smaller than current flying systems (less than 15 cm in any dimension) will be developed and demonstrated. The capability to accomplish unique military missions as diverse as covert imaging in constrained areas, biological-chemical agent detection and characterization, remote precision mines, and urban battlefield communications enhancement, will be stressed through an examination of a variety of vehicle concepts. The resulting capability should be especially beneficial in the emerging urban warfighting environment, characterized by its complex topologies, confined spaces and areas (often internal to buildings), and high civilian concentrations. The µAV program will focus on the technologies and components required to enable flight at these small scales, including flight control, propulsion and lightweight power, navigation and communications, building upon and exploiting numerous DARPA technology development efforts, including advanced communications and information systems, high performance computer technology, Microelectro-mechanical Systems (MEMS), advanced sensors, lightweight, efficient high density power sources, and advanced electronic packaging technologies.

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(U) The Unmanned Aerial Vehicle (UAV) Guided Parafoil for Logistics Resupply program will develop an affordable system to covertly and rapidly provide logistic supplies to forward deployed forces, especially small unit operations (SUO) forces involved in covert missions. The program will refine operational concepts, performance, cost goals, and build service consensus. The program builds on DARPA's Small Engine Application Program (SENGAP) engine and Global Positioning System (GPS) navigation system technologies to contribute directly to SUO desired capabilities for just-in-time logistics. The resulting UAV, to be demonstrated n four years, would be tested in the military operations in urban terrain testbed designed specifically to evaluate SUO technologies.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program: N/A

(U) FY 1998 Program:

- An Autonomous Inspection and Continuous Built-in-Test architecture will be developed and followed by a system preliminary design. Critical component development will also be pursued. ($6.0M)
- The Micro-Aerial Vehicles (µAV) Program will initiate development of three functionally diverse flight systems, employing alternative technology solutions. These systems will be chosen based on potential exhibited for military applications. Preliminary designs and key component development will be followed by feasibility demonstrations. Development of separate individual high risk, high payoff technology components will also be initiated. ($8.0)
- Unmanned Aerial vehicle (UAV) Guided Parafoil: Investigate range, payload, navigation and control system capabilities of power assisted parafoil. Conduct sensitivity analysis relating to power assistance, parafoil alternatives, and navigation and control system alternatives. Conduct operational concepts review for the baseline system and promising alternative systems with appropriate services. Initiate competitive procurement to design, fabricated and test low cost UAV parafoil. ($6.0M)

(U) FY 1999 Program:

- Autonomous Inspection and Continuous Built-in-Test subsystem fabrication will be followed by development testing and feasibility demonstrations. Integration of system components into a suitable testbed aircraft will also be initiated. ($12.0M)

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- The Micro-Aerial Vehicle (µAV) Program will finalize system designs and initiate fabrication of candidate systems. These systems will be developed and tested against an operational template derived from the design flight characteristics. Prototype units are expected to be nearing completion at the end of the fiscal year. ($15.0M)
- Refine UAV Parafoil program concept of operations; continue UAV Parafoil fabrication and testing and conduct system validation demonstrations. ($13.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	10.0	10.0
Appropriated	0	N/A	N/A	N/A
Current Budget	0	0	20.0	40.0

(U) **Change Summary Explanation**:

FY 1998-99 Addition of the following programs: Autonomous Inspection and Continuous Built-in-Test (ACBIT) program, Micro-Air Vehicle (µAV) Program, Unmanned Aerial Vehicle (UAV) Guided Parafoil for Logistics Resupply.

(U) **Other Program Funding Summary Cost**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Logistics Technology TT-10	6,328*	17,185	23,685	21,665	10,633	10,000	10,000	0	0	N/A

* This TT-10 effort also includes Advanced Logistics efforts included under PE 0602301E, Project ST-11.
4,092

(U) **Mission Description:** The Advanced Logistics Technology Program will investigate and demonstrate technologies that will make a fundamental difference in transportation and logistics. The program will define, develop, and demonstrate fundamental enabling technologies that will permit logistics and transportation assets to be deployed, tracked, refurbished and redeployed more efficiently than ever before. Currently, these assets are being managed using isolated, independent, and sometimes incompatible computer systems. Therefore, the very rapid replanning and redirection necessary to support missions involving simultaneous local and major regional conflicts cannot be accomplished today. The Advanced Logistics Program will enable this significant capability to be developed. In addition, the project has enormous potential for cost savings through greatly improved management of transportation and logistics assets.

(U) Additionally, this program will develop multi-echelon, collaborative logistical/transportation support tools that will provide warfighters an unprecedented capability to monitor, rapidly replan and re-execute movement, even while enroute to the theater. The Advanced Logistics Program will focus on three areas: 1) Development of a computer network infrastructure that allows distributed real-time visualization and interaction with all phases, elements and components of the military and commercial transportation infrastructure; 2) Development of applications providing a technology environment that allows warfighters to rapidly understand and assess the logistics and transportation implications of a crisis situation, to generate effective plans and courses of action, to monitor a plan's execution, and to use that information to re-plan; 3) Systems that will enable significant efficiency improvements in transportation and logistics, such as monitoring the condition of assets and the infrastructure, the creation of "plan sentinels" to serve as an early warning system for plan deviations, and improved theater distribution. the capabilities from these three areas will be integrated to demonstrate an end-to-end system solution.

(U) The Advanced Logistics Program supports joint initiatives with the Defense Logistics Agency and is coordinated with other related logistics efforts within the DoD. As technology matures, it will immediately transition to these initiatives which include: the Global Transportation Network (GTN), Joint Total Asset Visibility Program (JTAV), and the Joint Logistics Advanced Concept Technology Demonstration. The migration path for the end-to-end system solution

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will be through the Leading Edge Services Joint Program Office for the Global Command and Control System (GCCS) and the Global Combat Support System (GCSS).

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Initiated development of a distributed logistics and transportation network including development of information manipulation and planning tools to support planning, execution, monitoring and focused replanning throughout the logistics pipeline. ($4.3M)
- Initiated definition of technology requirements for data gathering and measurement of the logistics execution environment including data gathering tools for semi-autonomous capture, search and retrieval of data in disparate defense and commercial logistics sources and advanced tagging/locating/measurement sampling systems and software. ($2.0M)

(U) FY 1997 Program:

- Continue architecture development and demonstrate a distributed logistics planning, execution, and monitoring system concept to support inland military logistics planning/replanning from origin to port. ($6.0M)
- Conduct a feasibility demonstration of advanced technologies for logistics support planning, measurement sampling, and software systems. ($3.0M)
- Initiate proof of principle for advanced software data collection techniques (also referred to as knowledge rovers or intelligent software agents) that search the Global Information Infrastructure for relevant logistics information and data and return it to the user. Initiate development of multi-echelon collaborative logistical support tools that integrate planning, execution, monitoring and decision support systems for testing and deploying these tools. Conduct concept formulation and initial utility demonstration of "plan sentinels" to detect plan deviations within a rapid replanning environment. Develop an integrated software framework that is reusable and reconfigurable. ($8.2M)

(U) FY 1998 Program:

- Demonstrate an integrated computer environment to support the planning, execution and monitoring of a major force deployment from fort to port to ship load, including optimized scheduling and routing with minimal staging throughout the move. ($6.0M)
- Initiate development of plan deviation detection sentinels and predictive analysis to assist in identification of replanning opportunities. ($8.0M)

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- Continue development of advanced software data collection techniques. Initiate development of a Dynamic Critical Items List for sustainment planning and execution. Continue development of multi-echelon collaborative logistical support tools. Develop and demonstrate coarse-grained course of action evaluation that is linked to the war plan. ($9.7M)

(U) FY 1999 Program:

- Demonstrate an integrated environment to support the planning, execution and monitoring of a major force deployment from point of debarkation through in-theater distribution, including automated infrastructure assessment and monitoring. ($6.0M)
- Develop and demonstrate the ability to negotiate the exchange of information between suppliers and buyers, including rapid, flexible item and item relationship catalogs. ($7.0M)
- Extend "plan sentinels" for automated deviation detection and triggering of the replanning processes. Continue development of a Dynamic Critical Items List for sustainment planning and execution. Develop and demonstrate medium grained course of action evaluation that is linked to the war plan. ($8.7M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	17.2	28.7	16.7
Appropriated	N/A	N/A	N/A	N/A
Current Budget	6.3	17.2	23.7	21.7

(U) **Change Summary Explanation**:

1996 Reflects the consolidation of transportation technologies from Strategic Computing and Naval Warfare Technology into a new project for greater visibility.

1998-99 Decreases reflect rephasing of the planned requirements for this project.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Integrated Command and Control Technology, PE 0602708E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
High Definition Systems IC-03	47,329	45,000	45,000	45,000	45,000	45,000	0	0	0	N/A

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because it develops the technology and manufacturing capability for high definition displays and is important for virtually all DoD applications that involve visual and graphic information. Major components of this program include: projection, head mounted and direct view displays based on multiple technologies; development of equipment and components required to manufacture advanced display technologies, and prototype display systems for system evaluation. These efforts will establish a domestic technical capability and demonstrate the manufacturing capability of components necessary for military systems that capture, process, store, distribute and display high resolution images.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Continued development of flat panel and projection displays for mobile displays, and shipboard and landbased command and control centers. ($19.3M)
- Continued development of equipment and components to meet display cost and performance goals. This will include efforts in patterning, film deposition and annealing, and field emission display materials and assembly tools, as well as reflective liquid crystal materials and phosphor technology development. ($20.0M)
- Developed system prototypes which leverage earlier developed display technologies and incorporate integrated systems and intelligent interfaces. ($8.0M)

(U) FY 1997 Program:

- Initiate development of next generation reflective and emissive mobile display technologies and laser based projection systems for command and control applications. ($13.0M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in field emission display materials, organic light emitting materials, reflective liquid crystal materials, phosphor technology development, and support for domestic display manufacturing infrastructure. ($22.0M)
- Continue development of system prototypes which leverage earlier developed display technologies and incorporate integrated systems and intelligent interfaces. ($10.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
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(U) FY 1998 Program:

- Continue development of next generation reflective and emissive mobile display technologies and systems for command and control applications, including laser based projection. ($13.0M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in printing and microreplication, field emission display materials, organic light emitting materials, phosphor technology development, and support for the domestic display manufacturing infrastructure. ($22.0M)
- Continue development of system prototypes which leverage earlier developed display technologies, particularly for mobile displays and incorporate integrated systems and intelligent interfaces. ($10.0M)

(U) FY 1999 Program:

- Complete development of next generation reflective and emissive mobile display technologies and continue development of displays for command and control applications, including laser projection displays. ($12.0M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in printing and microreplication, field emission display materials, organic light emitting materials, phosphor technology development and support for the domestic display manufacturing infrastructure. ($20.0M)
- Complete first generation integrated display systems and system prototypes for mobile applications. Continue development of large screen command and control system prototypes. ($13.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	48.0	45.0	45.0	45.0
Appropriated	48.7	N/A	N/A	N/A
Current Budget	47.3	45.0	45.0	45.0

(U) **Change Summary Explanation**:

FY1996 Decrease reflects reprogramming action in support of Bosnia.

(U) **Other Program Funding Summary Cost**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Integrated Command and Control Technology, PE 0602708E, Project IC-03

(U) **Schedule Profile**: N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials and Electronics Technology	**231,759**	**218,539**	**228,811**	**287,346**	**310,725**	**332,708**	**383,799**	**408,799**	**Continuing**	**Continuing**
Materials Processing Technology MPT-01	117,441	110,208	110,976	140,797	147,550	163,327	193,327	204,327	Continuing	Continuing
Microelectronic Device Technology MPT-02	56,758	71,824	77,931	95,660	96,222	98,881	110,972	120,972	Continuing	Continuing
Cryogenic Electronics MPT-06	29,568	9,835	13,190	13,203	12,546	15,000	20,000	25,000	Continuing	Continuing
Military Medical/Trauma Care Technology MPT-07	27,992	26,672	26,714	37,686	54,407	55,500	59,500	58,500	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because its objective is to develop technology related to those materials, electronics, and medical devices that make possible a wide range of new military capabilities.

(U) The Materials Processing Technology project (MPT-01) concentrates on the development of novel materials, materials processing techniques, and fabrication strategies for advanced structural and functional materials and components which will lower the cost, increase the performance, and enable new missions for military platforms and systems. Areas of concentration include exploitation of emerging processing approaches and mathematical models to tailor the properties and performance of structural materials and devices. This emphasis includes lightweight personnel protection, mesoscale machines for miniature devices, and ultra lightweight materials. The project also focuses on smart materials, sensors and actuators, and functional materials and devices, including novel thermoelectric materials, solid-state coolers, and advanced magnetic materials. Other areas of concentration include new materials concepts for portable power, protective coating materials to eliminate environmental hazards, and development of bio-interface materials and methods.

(U) The Microelectronics Device Technologies project (MPT-02) develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics and infrared devices. Areas of emphasis include high-performance analog-to-digital converters, military optical processors, novel optoelectronic

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
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devices and components, high temperature electronic devices, and high power electronics. This project includes a significant effort to develop advanced materials and device technology beyond the classical scaling limits of silicon device technology.

(U) In the Cryogenic Electronics project (MPT-06), thin film electromagnetic material have reached a stage of development where specific applications can be identified in electronic devices and circuitry for military applications. Thin-film high temperature superconducting components packaged with cryogenic devices are being applied to radars, electronic warfare suites, and communications systems to enhance performance while reducing size and power requirements. Highly dependable and inexpensive cryocoolers (including thermoelectric coolers) are being developed for these applications, and new efforts will explore techniques to improve cryogenic performance of all solid state thermoelectric coolers as well as the overall cryogenic performance in applications ranging from communications to computing.

(U) Military Medical/Trauma Care Technology project (MPT-07) is an initiative to significantly improve far-forward battlefield trauma care. The Advanced Biomedical Technology portion focuses on the human factors of advanced technology concepts in a front-line battlefield environment through development of body-worn monitors, field-portable digital imaging equipment, and battlefield surgical simulator. The Health Care Information segment concentrates on development of physician, medic, and community information associates for utilization by both medics during combat care scenarios and physicians during patient visits.

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DATE: May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials Processing Technology MPT-01	117,441	110,208	110,976	140,797	147,550	163,327	193,327	204,327	Continuing	Continuing

(U) **Mission Description**: Among the major goals of this project are to develop novel materials, materials processing techniques, and fabrication strategies for advanced structural and functional materials and components which will lower the cost, increase the performance and/or enable new missions for military platforms and systems. One important area of concentration is the exploitation of emerging processing approaches and mathematical models to tailor the properties and performance of structural materials and devices. Thrusts in this area include new concepts for lightweight personnel protection, mesoscale machines for miniature devices, and ultra lightweight materials for lowering the weight and increasing the performance of aircraft and spacecraft structures. Smart materials, sensors and actuators for the control of the aerodynamic and hydrodynamic behavior of military systems are being developed and demonstrated in order to increase performance and lower detectability of aircraft, helicopters and submarines. Another major thrust is the development of functional materials and devices, including novel thermoelectric materials for high efficiency, all solid-state coolers and advanced magnetic materials for non-volatile, radiation hardened magnetic memories with very high density, short access time, infinite cycle ability and low power. New materials and concepts for increasing the availability of portable power to the soldier are also being investigated as are substitute protective coating materials which eliminate environmental hazards.

(U) Other areas of concentration seek to 1) develop bio-interface materials and methods for preventing pathogens from entering the warfighter's body, and 2) once in the body prevent them from causing disease. Approaches include advanced biomaterial barriers and elimination techniques to prevent pathogen entry and augmenting the warfighter's immune response to pathogens.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Structural Materials and Devices. ($33.9M)
  - Demonstrated full-scale rapid densification of carbon-carbon composite components.
  - Demonstrated a five-fold improvement in the life of the roll reaction control (RRC) valve bearings on the AV-8B Harrier aircraft due to the upgrade of the metal bearings with ceramic hybrid bearings.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Validated the Resonant Ultrasonic Inspection technique for ceramic rolling elements through beta site testing at a commercial ball bearing finisher.
- Demonstrated production of voided and foamed aluminum and titanium core materials for ultra lightweight panels.
- Demonstrated low cost aluminum-beryllium aerostructure fabrication processes.
- Demonstrated reduced mean-time-between-failure (MTBF) associated with the upgrade of glass optical domes to spinal domes used in the Angle Rate Bombing Set (ARBS) of the AV-8B Harrier aircraft.
- Initiated new Advanced Materials Partnerships in low cost metals processing and advanced ceramics.
- Demonstrated the use of X-ray tomography and developed software to generate computer aided design (CAD) files from solid objects compatible with the requirements of solid freeform fabrication.
- Developed the machine capability to produce silicon nitride components using the fused deposition method with silicon nitride powder loaded wax filaments.
- Demonstrated the capability to fabricate molds for slip casting structural ceramics using 3-D printing technology.
- Demonstrated an advanced polarization preserving fiber optic connector.
- Developed a chemical vapor deposition (CVD) process for the fabrication of particulate and chopped fiber reinforced composites with a 10X increase in composite growth rate over normal CVD processing; demonstrated the utility of the fabricated composites for the die casting of copper alloys.
- Designed, fabricated and evaluated fiber reinforced ceramic matrix composite fins for the Army's Line of Sight Anti-Tank (LOSAT) missiles with a 50% weight savings over the current materials (primarily steel).
- Developed feedback control methods for plasma sprayed metal matrix composites.

• Smart Materials and Actuators. ($21.6M)
  - Demonstrated application of smart materials to reconfigurable machines and tooling hardware.
  - Analyzed smart materials applications for submarines.
  - Demonstrated material sensor and activator components manufacturability utilizing piezoelectric ceramics and electrostrictors.

• Functional Materials and Devices. ($40.3M)
  - Demonstrated prototype multichip modules (MCM) with laminate technology roll to roll processing.
  - Demonstrated a prototype MCM for a missile guidance section using a bare die on a laminate substrate and electronically validated performance.
  - Developed magnetoresistive materials with improved electrical resistance properties.
  - Developed simulation codes for the physics of vapor deposition and validated on industrial processes.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Demonstrated a process to produce elastomeric electrorheological materials for acoustic wave filtering applications.
- Large area, high deposition rate chemical vapor deposition (CVD) of diamond substrates has been demonstrated.
- Processing approaches have been identified for manufacturing high thermal conductivity (>10W/K-cm), low-cost (<$1/carat) diamond for thermal management of defense electronics.
- Initiated the demonstration of thermal management diamond in specific defense applications (e.g., high power transmit-receive modules, electronic warfare (EW) systems).
- Developed stable contacts for high temperature, high power semiconductors.
- Demonstrated high yield large area processing of thin film high temperature superconducting devices.
- Developed giant magneto-resistive (GMR) films with enhanced electrical characteristics.
- Enhanced magneto-resistance ratio at low magnetic fields for faster response and higher sensitivity of devices.
- A model magnetic memory cell design was completed.

• Energy and Environmental Sciences. ($13.8M)
- Designed and initiated construction of a hydrothermal oxidation system for shipboard excess hazardous material disposal.
- Demonstrated more environmentally sound production processes for printed wiring boards.
- Sensors and control models for the intelligent processing of materials were designed to improve the reliability of thermal barrier coatings for turbine engine airfoils and have been demonstrated on a production scale reactor.
- Initiated studies of advanced erosion/corrosion resistant thin film coatings.
- Process parameters for the manufacture of copper-indium diselenide (CIS) photovoltaic solar cells have been established and demonstrated in production scale efficiencies of over 8% (photons in to electrons out).

• Biological Warfare Defense. ($7.8M)
- Developed integration technology to insert up-converting phosphors into existing biological warfare agent sensors.
- Demonstrated feasibility of an aflatoxin biosensor.
- Designed microfabricated polymer bilayer air-fluid sampling inlet.
- Determined performance characteristics of biological sensors in multiple environments.
- Identified, purified, and crystallized target enzymes for inhibition of spore germination.
- Developed reference architecture for smart messages system.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

(U) FY 1997 Program:

- Structural Materials and Devices. ($38.6M)
  - Demonstrate a 2X increase in mean-time-between-failures (MTBF) associated with the replacement of carbon engine starter oil face seals on aircraft with ceramic face seals.
  - Continue advanced materials partnerships in structural materials: demonstrate low cost processing of ceramic composites for jet engines; demonstrate a versatile process for lowering the cost of hot isostatic pressing of superalloy powders.
  - Demonstrate production of titanium components using laser sintering techniques.
  - Demonstrate production of cast aluminum-beryllium components.
  - Demonstrate secondary processing and joining of ultra lightweight panels.
  - Demonstrate the capability to produce ceramic components with complex geometry and dimensional tolerances and mechanical properties comparable to mass manufactured advanced ceramics using the Jet Printer technology (3-D printing).
  - Develop a new solid freeform build method for ceramic components based on layer-by-layer photolithography utilizing either large area liquid crystal display, or a light emitting diode display technology for electronically programmable photomasks.
  - Test reconfigurable machines and tools in shop floor beta test sites.
  - Determine the performance characteristics of low cost, damage tolerant fibrous monolith components in engine environments.
  - Demonstrate control of plasma sprayed metal-matrix processing and extend process control models to physical vapor deposition of metal coated fibers.
- Smart Materials and Devices. ($24.9M)
  - Demonstrate fabrication process for microintegrated smart materials.
  - Demonstrate vibration reduction by a factor of ten in machine tools via specially designed sensor/actuator elements to enhance machining tolerances.
  - Determine the economic viability of Templated Grain Growth (TGG), a process by which solid phase epitaxy of crystallographical oriented seeds on near net shaped polycrystalline components is used for growth of single crystal-like oxides.
- Functional Materials and Devices. ($33.5M)
  - Complete development of a plasma/ion etch numerical simulation.
  - Demonstrate predictive capability of high-pressure, low-order, chemical vapor deposition models and demonstrate feedback control to a desired wafer state.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Demonstrate intelligent processing of large area chemical vapor deposition (CVD) of diamond with production costs of $1/carat.
- Demonstrate the advantages of thermal management diamond in the performance of defense electronic systems or subsystems.
- Grow single crystal boules for three inch diameter silicon carbide semiconductor wafers by scaling up the reactor and developing larger seed crystals.
- Demonstrate high temperature superconducting technology with greater than fifteen square inch format and greater than eighty percent yield.
- Demonstrate large area deposition of gigantic magneto-resistive (GMR) materials.
- Fully characterize spin transistor and other spin polarized transport devices for use in ultra-high density memory applications.
- Demonstrate prototype GMR magnetic memory cell and spin transistor memory cell using magnetic multilayers.
- Broaden scope of advanced materials partnerships to include: the development of advanced thermoelectric materials and devices; the application of biomolecular materials and biomimetic materials to military concerns; and novel application of nano-structured materials.

• Energy and Environmental Sciences. ($13.2M)
- Demonstrate a hydrothermal oxidation pilot plant for the destruction of shipboard excess hazardous materials.
- Demonstrate novel recycling/reclamation techniques for disposal of scrap polymer matrix composites.
- Demonstrate intelligent processing of thermal barrier coatings yielding reliable coatings which increase turbine engine inlet temperatures by up to 200 degrees F, with a commensurate increase of 10-15% in thrust.
- Develop advanced erosion/corrosion resistant thin film coatings for military applications.
- Demonstrate high yield, pilot scale production (1.5 megawatt/year) of high efficiency (10%) copper-indium diselenide (CIS) solar cells on flexible substrates; test in a military environment.

(U) <u>FY 1998 Program</u>:

• Structural Materials and Devices. ($33.7M)
- Demonstrate low cost titanium and superalloy component fabrication processes.
- Demonstrate uniformly bonded face sheet attachment on ultra lightweight foamed metal structure.
- Demonstrate a 5x reduction in prototyping time (print-to-part) for ceramic and metal gas turbine engine components utilizing solid freeform manufacturing.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Demonstrate laser workcell at a beta test site.
- Establish approaches for breakthrough gains in personnel protection performance (e.g., >100% from current capabilities for 7.62 mm armor piercing (AP)) through the application of innovative materials, materials processing and phenomenological modeling of multicomponent materials systems.
- Build a high precision silicon nitride roll gimbal and pitch shaft for an infrared (IR) seeker utilizing Shaped Deposition Manufacturing (SDM), which combines additive and subtractive processing.
- Demonstrate the application of new processing approaches (e.g., solid freeform fabrication (SFF)) for controlling the dimensional tolerances, microstructural properties and affordability required for mesoscale machines; select and begin a specific mesoscale machine demonstration of interest to DoD (micro engine generator, mini compressor, etc.)

• Smart Materials and Actuators. ($24.7M)
- Demonstrate smart material active helicopter blade structures and acoustic noise suppression structure.
- Evaluate actuation potential of magnetoelastic transducer materials.
- Evaluate high performance electroceramic actuator fabrication processes.
- Demonstrate smart shape adaptive wing.
- Design, build, test and evaluate high power laminated actuator stacks for smart defense structures utilizing Computer Aided Manufacturing-Laminated Engineering Materials (CAM-LEM) SFF capability.

• Functional Materials and Devices. ($12.5M)
- Demonstrate a prototype gigantic magneto-resistive (GMR) magnetic memory cell and spin transistor memory cell using magnetic multilayers.
- Begin design and construction of a very high sensitivity magnetometer.

• Energy and Environmental Sciences. ($14.3M)
- Demonstrate the utility of advanced erosion/corrosion resistant thin film coatings at a military site.
- Extend concepts of intelligent processing of thermal barrier coatings to complex multilayer systems capable of an additional 200 degrees F in turbine inlet temperature (10-15% additional thrust) without sacrificing reliability.
- Develop balance-of-plant and packaging for a direct oxidation fuel cell replacement for military standard batteries.
- Demonstrate that full scale, intelligent processing of copper-indium diselenide (CIS) solar cells yields both performance and cost (<$1/Watt) suitable for use of flexible photovoltaics in military operations.

• Pathogen Countermeasures. ($25.8M)
- Establish a preliminary approach for stem cells to detect pathogens (in cell culture).
- Establish a portfolio of pathogen defense components which can be linked to the red blood cell.

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- Optimize the linkage strategies to be used for decorating the surface of modified red blood cells with pathogen defense components.
- Determine the impact of modified red blood cells on the coagulation and immune systems.
- Establish a portfolio of strategies to:
  * inhibit the expression of disease-causing (virulence) factors by pathogens.
  * disrupt the disease-causing (virulence) communications between pathogens.
  * modulate the body's response to the presence of a pathogen.

(U) <u>FY 1999 Program</u>:

- Structural Materials and Devices. ($31.2M)
  - Evaluate materials and materials systems concepts designed to significantly improve personnel protection performance (e.g., >100% from current capabilities for 7.62 mm armor piercing (AP)), dramatically increasing protection for the individual soldier.
  - Demonstrate solid freeform fabrication of titanium forging blanks.
  - Demonstrate spray forming of superalloy forging billets.
  - Demonstrate the use of Solid Freeform Manufacturing to upgrade distressed turbine vanes in man rated gas turbine engines with ceramic composite components of high reliability.
  - Demonstrate the construction and performance of a prototype mesoscale machine.
- Smart Materials and Actuators. ($28.9M)
  - Evaluate aluminum-beryllium (Al-Be) F-15 rudder span.
  - Demonstrate vortex wake reduction using smart materials.
  - Demonstrate submarine acoustic noise reduction using smart material tiles.
- Functional Materials and Devices. ($15.2M)
  - Demonstrate high speed, low density, non-volatile magnetic memory utilizing magnetic multilayers.
  - Demonstrate very high sensitivity magnetometer.
  - Initiate a program to demonstrate a new process for the fabrication of silicon carbide (SiC) devices using rapid tooless vapor deposition processes.
- Energy and Environmental Sciences. ($12.7M)
  - Demonstrate a low temperature, packaged direct oxidation fuel cell for soldier applications.
  - Demonstrate alternative energy sources for soldier microclimate cooling and for portable battery chargers.
  - Complete demonstration and insertion of advanced erosion/corrosion resistant thin film coatings in military systems.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Pathogen Countermeasures. ($52.8M)
  - Develop a modified stem cell which can both detect and produce a vaccine/therapeutic response to a pathogen (in cell culture).
  - Optimize the detection of a small set of specific pathogens by stem cells (in cell culture).
  - Define animal models in which to test the efficacy of modified red blood cells to defend against pathogens.
  - Demonstrate selected strategies (in cell culture) to:
    * inhibit the expression of disease-causing (virulence) factors by pathogens
    * disrupt the disease-causing (virulence) communications between pathogens
    * modulate the body's response to the presence of a pathogen.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	122.7	110.2	137.4	142.5
Appropriated	126.0	N/A	N/A	N/A
Current Budget	117.4	110.2	111.0	140.8

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects inflation savings, ($-2.5 million) termination of polymer matrix composite effort ($-4.1 million) and minor program repricing ($-2.0 million)

FY 1998 Decrease reflects transfer of chemical and biological defense program to OSD and termination of polymer matrix composite effort.

FY 1999 Decrease reflects minor program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE: May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microelectronic Device Technologies MPT-02	56,758	71,824	77,931	95,660	96,222	98,881	110,972	120,972	Continuing	Continuing

(U) **Mission Description**: This project develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics and infrared devices. Areas of emphasis include high performance analog-to-digital converters (ADCs), military optical processors, novel optoelectronic devices and components, high temperature electronic devices and high power electronics. This microelectronics development project develops and demonstrates advanced microelectronics technology for DoD critical needs. Technologies developed in this project are performance driven and exceed commercial capabilities. This project includes a significant effort to develop advanced material and device technology beyond the classical scaling limits of silicon device technology.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Developed heterojunction bipolar transistor process, device, and design technologies for application in high-speed analog-to-digital converters, digital-to-analog converters, multiplexers, and demultiplexers. ($9.2M)
- Delivered the first-generation of hardware and software for advanced image processing. ($6.4M)
- Completed development of advanced electronic neural network technologies for target tracking and recognition applications. ($6.5M)
- Developed critical materials, processes, and device technologies for .25µm silicon-on-insulator semiconductor fabrication. ($8.5M)
- Developed optoelectronics technologies to enable cost-effective fabrication and integration of module subassemblies for digital optoelectronic processors, bus and backplanes, and serial/parallel input/outputs. ($25.6M)
- Initiated efforts to design radio frequency photonic components for transmission of millimeter waves and microwaves. ($.6M)

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(U) FY 1997 Program:

- Complete hardware/software integration for advanced vision system, and demonstrate image recognition. ($8.5M)
- Demonstrate functionality and operation of high performance optoelectronic, digital processor prototype and develop advanced optoelectronic fabrication approaches and subassembly component technologies. ($20.7M)
- Develop component and fabrication technologies for radio frequency photonic components for application in millimeter wave and microwave transmission. ($7.7M)
- Improve silicon-on-insulator (SOI) materials and device fabrication methodologies to enable a low power, radiation tolerant, 0.18µm technology generation. ($10.4M)
- Initiate efforts to develop advanced digital-based radar processor components based on high speed semiconductor technologies, such as heterojunction bipolar transistors. ($6.0M)
- Demonstrate operation of semiconductor switches, based on silicon-carbide materials, capable of sustained handling of high electric power. ($4.7M)
- Develop high speed mixed signal packaging environment and integration approaches for ADC processor elements. ($2.0M)
- Extend HBT device technology to enable 75 dB spur-free dynamic range (SFDR) ADC processor performance. ($5.0M)
- Develop common complementary metal oxide semiconductor/silicon-on-insulator (CMOS/SOI) materials requirements to support low power electronics and radiation hardened performance requirements. ($2.0M)
- Initiate efforts to extend high performance mixed signal device technology to geometries below 0.18 micron. ($4.8M)

(U) FY 1998 Program:

- Advanced Microelectronics Materials and Device Technology - Develope materials, devices and integration approaches for mesoscopic devices with performance metrics below 50 nm CMOS. This includes the development of large area atomic layer material growth, quantum level device modeling and material optimization. ($30.0M)
- Advanced Microelectronics Process and integration Technology - Develope shallow junction doping techniques. Low thermal excursion and low damage processes which are compatible with the required atomic layer materials. This will require the development of in-situ process sensors to optimize process end points and to provide real time manufacturing feedback control and model development. ($23.M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-02

- Optoelectronics - Demonstrate critical optical elements and emitter based smart pixel arrays for high payoff 3-D based optoelectronic engine for military battlefield information systems which can significantly impact: reconfigurable switching, 2-D image decompression/compression, and high speed parallel memory access. ($11.5M)
- Digital Radar - Continue efforts to develop advanced digital-based radar processor components based on high speed semiconductor technologies, such as heterojunction bipolar transistors. ($10.0M)
- A/D Converters - Develop integrated CAD tool set for high speed designs and demonstrate high speed analog-to-digital prototype. ($3.0M)

(U) FY 1999 Program:

- Advanced Microelectronics Materials and Device Technology - Demonstrate viability of materials and device concepts for sub 50nm technology for a DoD application. ($45.0M)
- Advanced Microelectronics Process and Integration Technology - Demonstrate process integration of sub 50nm technologies for a DoD application with an approach to decoupling manufacturing cost form production volumes. ($31.2M)
- Optoelectronics - Verify capability of optoelectronic engine to outperform conventional electronic systems by factor of greater than X 100 for specific computation intensive military signal processing problems such as STAP (Space Time Adaptive Processing) eg: for acoustic/digital radar signatures processing. ($8.5M)
- Digital Radar - Develop advanced digital processor components. ($10.0M)
- A/D Converters - Complete prototype demonstration. ($1.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	62.2	71.8	87.2	95.4
Appropriated	60.7	N/A	N/A	N/A
Current Budget	56.8	71.8	77.9	95.7

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-02

(U) **Change Summary Explanation**:

FY 1996 Decrease due to Bosnia reprogramming action ($-1.2 million), below threshold reprogramming ($-1.9 million) and SBIR transfer to PE 0605502E ($-.8 million).
FY 1998 Decrease due to a reprioritization of DoD resources.
FY 1999 Increase due to minor program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Cryogenic Electronics MPT-06	29,568	9,835	13,190	13,203	12,546	15,000	20,000	25,000	Continuing	Continuing

(U) **Mission Description**: Thin film electromagnetic materials have reached a stage of development where specific applications can be identified in electronic devices and circuitry for military systems. Films are deposited and patterned to form electromagnetic components in ways that are similar to, and compatible with the processes of semiconductor processing. Such electromagnetic components, as well as complementary metal oxide semiconductors (CMOS), work best at lower temperatures, so that cryogenic packaging generally will be required for highest performance. Thin-film high temperature superconducting (HTS) components packaged with cryogenic devices are being applied to radars, electronic warfare suites, and communications systems to enhance performance by more than an order of magnitude while reducing size and power requirements. Particular demonstrations include an upgraded ship-defense radar (SPQ-9B) with 100X greater detectability of missiles in littoral clutter, and a switchable filterbank with 24 individually tuned high-performance filters to suppress Electronic Warfare (EW) saturation in radar warning receivers. Highly dependable and inexpensive cryocoolers (including thermoelectric cryocoolers) are being developed for these applications, and new efforts will explore techniques to improve the performance of all solid state thermoelectric coolers as well as the overall cryogenic performance in applications ranging from communications to computing.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- High Temperature Superconductors/Analog and Digital Applications ($13.8M): In this final year of the HTS Program, components were evaluated for integration within military avionics.
  - Continued integration of 24-element filterbank with refrigerator for application to F-15 aircraft.
  - Evaluated cryo-radar with HTS stabilized oscillator (STALO), at NRL Chesapeake Bay Facility.
  - Completed funding for Consortium for Superconducting Electronics.
  - Continued development of a high-performance 8x8 asynchronous transfer mode (ATM) cryogenic switch in a wide area network.
  - Developed simultaneously switchable and tunable high temperature superconducting (HTS) filters, preserving low insertion loss and high quality factors.
  - Examined applicability of 2nd generation HTS filters to interference reduction in communications sets, particularly SINCGARS radio.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-06

- Developed Broadband Waveform Generator incorporating HTS Josephson Junction array for Advanced Radar Applications.
- Developed small HTS magnets for energy storage and mine countermeasures.

• Cryogenics Technologies. ($15.8M)
- Developed small/inexpensive reliable cryocoolers.
- Developed electronic devices and components optimized for cooled operation.
- Initiated applications demonstrations with integrated cryocoolers and temperature-optimized components.
- Militarized several small low-cost cryocoolers for insertion into radar and Electronic Countermeasures (ECM) systems.
- Developed miniaturized cryopackage for High Stability Cryo-stabilized oscillator (STALO) for Airborne Radars.

(U) FY 1997 Program:

• Cryogenics Technologies. ($9.8M)
- Continue fabrication of cryo-radar, using HTS components and upgraded conventional components such as driver and active array, for final demonstration in FY98 with a simulated Naval scenario.
- Upgrade HTS switchable filter sets with tunable filters, for simpler construction and operation in aircraft Electronic Countermeasures (ECM) suites.
- Evaluate results of cryo-crossbar switch and asynchronous transfer mode (ATM) efforts. Determine most appropriate insertion for digital systems employing HTS devices as well as cryo-complementary metal oxide semiconductors (CMOS).
- Determine most important communications application of cryo-components.

(U) FY 1998 Program:

• Cryogenics Technologies. ($13.2M)
- Demonstrate, at an appropriate facility, a fully functional Cryo-Radar, with 108 dB dynamic range, 20 dB greater than present performance, showing capability to detect targets over that range and an ability to address the defense of surface ships to attacking missiles.
- Demonstrate the ability of Cryo-filterbanks to provide Electronic Counter-Countermeasures (ECCM) for aircraft receivers, in a scenario to be developed by Air Force.
- Demonstrate an improved analog to digital (A/D) converter employing cryogenic components.
- Demonstrate low-cost (less than $2500), highly reliable (greater than 30,000 hr) sterling cycle cryocooler that delivers 5 watts at 80K with less than 200 watts of total power.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-06

- Demonstrate new thermoelectric coolers using novel new materials that will provide a reduction in temperature greater than 50°C.

(U) FY 1999 Program:

- Cryogenics Technologies. ($13.2M)
  - Insert cryogenic packages in communication transceivers which mitigate electromagnetic interference effects.
  - Demonstrate digital waveform generation and signal processing using superconducting quantum devices.
  - Demonstrate pulse tube or sterling cycle cryocooler costing less than $1,500 in quantities of 1,000 with greater than 40,000 hr mean time before failure that delivers 5 watts of cooling at 70K with an input power of 150 watts or less.
  - Demonstrate thermoelectric coolers that can achieve 100°C cooling in less than three steps as compared to the current seven steps.
  - Demonstrate potential benefit of efficient power generation from thermoelectric devices operating at high temperature (approximately 500°C).

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	12.0	9.8	11.2	10.2
Appropriated	30.9	N/A	N/A	N/A
Current Budget	29.6	9.8	13.2	13.2

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects minor repricing.
FY 1998-99 Increases reflect expansion of crycoolers effort to include advanced thermoelectric materials.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials & Electronics Technology,
PE 0602712E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Military Medical/Trauma Care Technology MPT-07	27,992	26,672	26,714	37,686	54,407	55,500	59,500	58,500	Continuing	Continuing

(U) **Mission Description:** The objective of this project is to revolutionize far-forward battlefield trauma care. The project recognizes that planned downsizing of U.S. forces creates new pressures to ensure force readiness, skill mix, and effective joint doctrine at a time when battlefield casualties carry both strategic importance and tactical relevance. A review of combat casualty care has shown: (1) that 90% of combat deaths occur in the zone of close combat prior to medical or surgical intervention; (2) that fratricide continues at casualty rates as high as 20%-30%; (3) that casualty location is a continuing battlefield problem; and (4) that less than 5% of U.S. Army active-duty physicians have treated combat casualties.

(U) The DARPA Combat Casualty Care program has two major segments: (1) Advanced Biomedical Technology and (2) Healthcare Information Infrastructure. The first segment exploits DARPA's unique leadership role in the electronics and information sciences to project advanced medical and surgical care into the far-forward battlefield area to effect early, successful, clinical intervention. In one thrust, this program will develop lightweight personnel status monitors (PSMs) permitting remote non-invasive clinical diagnosis, casualty localization, and friend or foe identification. The PSM, which would be worn by all soldiers as part of their combat uniforms, is further augmented with low power, secure, wireless communications and a Global Positioning Satellite system (GPS). The PSM would monitor the soldiers' clinical vital signs continuously, but would remain otherwise passive unless either queried by an operational commander or the soldiers' vital signs departed from established clinical norms.

(U) In a second thrust, this program will develop the technology base for early far-forward medical/surgical intervention. Hemorrhage will be controlled by projecting the expertise of a surgeon with remote telepresence surgery. To preserve critical organ system function, reverse systemic shock, and prevent hypoxia there will be development of automatically controlled devices to provide immediate mechanical or pharmacologic therapy. Once pharmacologic or early surgical stabilization has been achieved, the patient will be evacuated in a critical care life support for trauma and transport pod (LSTAT) which will function like an autonomous single-patient hospital intensive care unit.

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(U) In a third thrust, workers will develop and exploit advanced simulation technology to improve the training of battlefield health care providers and to ensure skill currency. The objectives of this effort are to provide for the virtual representation of human structure and function; ensure near-seamless transition from training to clinical practice; and to permit simulation of combat-casualty medical care within the framework of operational battlefield requirements. The broader impact of whole-body virtual simulation on undergraduate and continuing medical education programs will allow military medical students to integrate traditionally separate academic disciplines and dramatically reduce the need for human cadavers or live animal wounding. Virtual prototyping is provided for medical environments such as mobile operating rooms, critical care life support for trauma and transport pod (LSTAT) and instruments/equipment inserted by casualty care simulations. New technologies for presenting information and training scenarios will be developed using human interface technologies.

(U) A fourth thrust will develop high-fidelity diagnostic imaging, particularly in biomedical applications of Computed Tomography (CT), ultrasound, infrared (IR), and conventional X-rays. For example the particular problem that is encountered in ultrasound imaging is that the medium (i.e., human) tissue is inhomogeneous and scatters the signal, which blurs the image. The processes for developing high-resolution imaging will build upon the emerging technology of adaptive acoustics, the displays of which are intuitive and easily interpreted by the combat medic and physician.

(U) In the other segment of the Combat Casualty Care program, the development of an advanced healthcare information infrastructure supports the entire trauma care technology base. Medical information must flow seamlessly and transparently on all levels of patient care. For this to occur, a platform-independent medical record system, such as the battlefield electronic patient record (BEPR), will ensure immediate continuity, distribution, and accessibility of medical information from the forward battlefield to the rear echelon support in U.S. based medical centers. This information will be achieved in multimedia heterogeneous databases of laboratory studies, radiologic and pathologic images, inpatient medical records, and be available over a world wide telecommunication system for real-time interactive collaboration among physicians. In addition, the infrastructure will provide a clinical associate system which is an intelligent system that assists physicians, nurses, corpsmen and paramedics in assessing and treating patients.

(U) This work does not duplicate any efforts of the Military Services or the National Institutes of Health. A Memorandum of Agreement exists between the Army Medical Department and DARPA.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials & Electronics Technology, PE 0602712E, Project MPT-07

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Advanced Biomedical Technology. ($16.3M)
  - Integrated closed-loop control algorithms for fluid infusion and mechanical ventilation support into the Personnel Status Monitor (PSM). Developed a specialty version (Ranger Overwatch PSM) with temperature, heart rate and motion sensors for insertion into Ranger training exercises.
  - Completed first prototype limb trauma simulator and delivered to U.S. Army Special Operations Command (USASOC) Medical Training facility.
  - Completed design and feasibility study to incorporate trauma simulator into the medic training on the virtual battlefield at the Dismounted Warrior Battle Lab (DWBL).
  - Completed 7 degrees of freedom (DOF) end-effectors and wireless communication packages for Remote Telepresence Surgery System.
  - Completed and delivered first prototype of life support for trauma and transport (LSTAT) (one for each service).
- Healthcare Information Infrastructure. ($6.2M)
  - Integrated models of combat doctrine and knowledge-based decision support tools (combat casualty protocols and guidelines) in support of combat medics and physicians.
  - Demonstrated hands-free capture of patient data under battlefield conditions.
  - Demonstrated integration of battlefield electronic patient record with peacetime care systems.
- 3-D Ultrasound Technologies. ($2.5M)
  - Developed test and evaluation battlefield/trauma ultrasonic imaging technology (using a 2D array equivalent) for 3D interpretation of body structures for insertion into Bosnia as a battlefield tele-ultrasound unit.
  - Continued development of Synthetic Aperture Radar processing techniques to determine those features which are pertinent to the ultrasonic imaging problem. Began testing algorithms which could mitigate the contribution of multiple scattering sites to image degradation.
- Biological Warfare Defense. ($3.0M)
  - Began characterization of immune response to sonicate inoculation in bacterial, viral and bio-engineered threat species.
  - Developed ionization source and curved-field reflectron for tiny mass spectrometer.
  - Preliminary exploration of approaches to transfect and characterize the induced genetic changes in stem cells or their derivative lineages for the purpose of potential defense against biological weapons.

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(U) FY 1997 Program:

- Advanced Biomedical Technology. ($14.6M)
  - Incorporate miniaturized Global Positioning Satellite (GPS) chip into Personnel Status Monitors (PSMs) for the transmission of vital sign and situational awareness data to battalion level command. Integrate PSM into full echelon casualty data for Joint Task Force (JTF) reference.
  - Incorporate full haptic interface (sense of touch) into limb trauma simulator, phase one of organ system surgical simulation, and integrate medic simulation into Dismounted Warrior Battle Labs (DWBL).
  - Develop interchangeable surgical tools for remote telepresence surgery and explore methodology for motion compensation (e.g., beating heart); insertion of beta version of Life Support for Trauma and Transport (LSTAT).
  - Extend the development of portable digital X-ray to 20 x 20 cm detector array, for field use and insert beta prototype of 3D ultrasound imaging into field test.
- Healthcare Information Infrastructure. ($7.5M)
  - Extend combat casualty protocol based care to disease (non-battle) injuries.
  - Demonstrate integration of combat casualty care data with Joint Task Force reference architecture for Global Combat Control System (GCCS) compliant data services.
- 3-D Ultrasound Technologies. ($4.6M)
  - Continue to develop and implement the techniques of adaptive acoustics to ultrasonic imaging, utilizing 2-D sensor arrays and image processing.

(U) FY 1998 Program:

- Advanced Biomedical Technology. ($15.6M)
  - Complete microminiaturization and field testing of PSM system, developing and integrating the sensate liner of microsensors into the system. Integrate and transition into 21st Century Land Warrior Program and USA Rangers.
  - Complete and deliver Telepresence Surgery system mounted in the Army Medical Department (AMEDD) Center and School chosen armored ambulance, with enhanced 6 degrees of freedom (DOF) manipulators, and operated wireless; advanced control theory to resolve latency (lag time) to remote sites.
  - Integrate micro-miniaturized components (ventilation, oxygen generator, monitors, power units) into beta version LSTAT with canopy. Demonstrate 3rd generation design of LSTAT which is NATO compatible.
  - Develop 3rd generation virtual simulation of battlefield injuries to solid organs as well as extremities with full physiologic responses such as bleeding and muscle twitching; integrate wound simulators into medic representation on virtual battlefield at DWBL.

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- 3-D Ultrasound. ($5.4M)
  - Continue to develop 2-D array ultrasound transducer.
  - Continue digital signal processing (DSP) for high-resolution, low signal-to-noise (S/N) ultrasound (US) image.
- Health Information Infrastructure Program (HIIP). ($5.7M)
  - Demonstrate transition of combat care associate system to military services.
  - Demonstrate force multiplying effect of associate system in combat care settings. Continue transition of associate systems architectures to include medical command and control (medical anchor desk) that support joint task force development.

(U) <u>FY 1999 Program</u>:

- Advanced Biomedical Technology. ($10.0M)
  - Continue development of enhanced dexterity micro manipulators.
  - Continue exploration of unconventional actuators (artificial muscles, MEMS, etc.)
  - Complete transition of Personnel Status Monitor, telepresence surgery, and casualty simulation technologies to the services.
- 3-D Ultrasound Technologies. ($6.0M)
  - Complete ultrasound enhancements for scattering, deabberation, and beam forming.
  - Demonstration of field-portable ultrasonic imager.
- Health Information Infrastructure Program (HIIP). ($6.0M)
  - Extend combat care associate system to manage force surveillance of combatants to battle situations and operations other than war.
  - Transfer protocol-based care toolkits to military services that will create and maintain combat casualty and disease non-battle injury protocols and guidelines.
- Surgical Robotics. ($15.7M)
  - Develop advanced interface design and micro-dexterity enhancement and effectors to telesurgical system.
  - Continue resolution of latency (lag time) to remote sites.
  - Develop system for motion compensation (e.g., surgery or moving platform or upon the beating heart).

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BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials & Electronics Technology,
PE 0602712E, Project MPT-07

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	29.1	26.7	31.2	37.7
Appropriated	24.3	N/A	N/A	N/A
Current Budget	28.0	26.7	26.7	37.7

(U) **Change Summary Explanation**:

FY 1996 Increase reflects Biological Warfare Program ($3.0 million), minor repricing ($1.1 million), inflation savings cited on reprogramming actions ($-.1 million), and SBIR transfer to PE 0605502E ($-.3 million).

FY 1998 Decrease reflects minor program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Experimental Evaluation of Major Innovative Technologies	**581,208**	**635,553**	**685,037**	**651,117**	**672,262**	**705,714**	**733,214**	**713,214**	**Continuing**	**Continuing**
Command & Control Information Systems EE-21	44,445	47,765	67,300	72,100	79,169	90,034	99,034	99,034	Continuing	Continuing
Aerospace Surveillance Technologies EE-27	3,000	0	17,000	14,000	12,000	16,200	25,000	27,000	Continuing	Continuing
Guidance Technology Program EE-34	11,876	10,499	21,100	21,100	28,112	30,800	35,200	52,000	Continuing	Continuing
Advanced Ship/Sensor Systems EE-36	24,314	18,844	20,330	44,096	81,478	89,696	109,696	119,696	Continuing	Continuing
Advanced Simulation EE-37	61,040	48,419	32,912	21,798	0	0	0	0	0	N/A
Unmanned Undersea Vehicle Systems EE-39	15,234	0	0	0	0	0	0	0	0	N/A
Critical Mobile Targets Systems EE-40	110,683	0	0	0	0	0	0	0	0	N/A
Air Defense Initiative EE-41	25,564	21,777	0	0	0	0	0	0	0	N/A
Global Grid Communications EE-45	42,807	42,024	43,392	43,916	44,750	49,549	54,549	49,549	Continuing	Continuing
Defense Simulation Internet EE-46	25,612	39,675	3,000	0	0	0	0	0	0	N/A

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RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Fast Ship/Future Ship EE-47	0	16,382	47,618	50,000	36,000	22,000	0	0	0	N/A
Combat Hybrid Power System EE-48	0	15,000	25,000	28,500	18,000	17,000	0	0	0	N/A
Tier III Minus UAV EE-49	23,201	14,749	5,000	0	0	0	0	0	0	N/A
Sensors & Exploitation Systems EE-50	0	69,201	85,854	92,755	109,400	116,787	135,287	135,287	Continuing	Continuing
Small Unit Operations EE-51	18,486	52,666	52,580	69,897	72,913	70,000	70,000	40,000	Continuing	Continuing
Information Integration Systems EE-53	0	67,914	98,400	105,300	105,000	121,000	118,800	110,000	Continuing	Continuing
Classified Programs EE-CLS	174,946	170,638	165,551	87,655	85,440	82,648	85,648	80,648	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Advanced Technology Development Budget Activity because its purpose is to demonstrate and evaluate advanced research and development concepts. Funding for fourteen projects are requested in FY 1998 within this program element such as Command and Control Information Systems, Information Integration, Small Unit Operations, and Global Grid Communications projects. A number of advanced concept technology demonstrations are funded within these activities. A discussion of the most significant projects follows.

(U) The Command and Control Information Systems project is developing the technologies necessary to facilitate joint campaign planning and control throughout the battlespace. The primary program in this

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project is the Joint Forces Air Component Command System, that will improve air combat coordination and targeting from initial planning through Air Task orders.

(U) A new project, Aerospace Surveillance Technologies, will pursue non-traditional approaches to surveillance ranging from digital terrain mapping to passive radar tagging.

(U) Advanced Simulation efforts will provide a distributed, scalable seamless warfighting environment at the weapon level of detail that will ultimately provide a massive synthetic theater of war capable of supporting such requirements as readiness training, doctrine refinement, requirements analysis, battle management simulation, and contingency planning. Communications and data infrastructures, range instrumentation and computer image generation are just a few of the developmental activities funded in the Advanced Simulation program.

(U) The Global Grid Communications project will develop and demonstrate advanced communications technologies needed for defense and intelligence operations for the 21st century. The ultimate goal is deployment of a gigabit network that will be interoperable with commercial, optical and secure wireless networks.

(U) The Advanced Ship-Sensor Systems project develops and demonstrates advancements in a wide range of technologies used in ship sensor, signal processing mechanical systems and advanced maritime platforms to significantly enhance the capabilities of naval and maritime forces.

(U) Five projects initiated in FY 1997 continue in FY 1998: 1) Fast Ship/Future Ship (EE-47) is a joint project with the Navy to develop the Arsenal Ship to enhance naval battle support; 2) Combat Hybrid Power Systems (EE-48) efforts will develop electric power management and control technologies for use in hybrid electric/diesel powered combat vehicles; 3) Small Unit Operations (EE-51) will explore and develop the technologies to expand the capability of squad-level warfighters to control large battlespaces, remotely engage enemy targets, and operate across a wide spectrum of conflict situations; 4) Information Integration Systems (EE-53) will develop enhanced means to evaluate and compress the massive data streams provided by modern surveillance systems so that the information required by battlefield combatants is available on a near real time basis; and 5) Sensor and Exploitation Systems programs (EE-

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50) are addressing imagery data collection processing capabilities by developing a Semi-Automated Imagery Processing advanced concept technology demonstration to enhance battlefield situational awareness, as well as developing sensor assets and evaluating the exploitation of sensor products.

(U) This program element also includes efforts in advanced Guidance/Targeting technologies, and FY 1998 marks the final year of DARPA funding for the Defense Simulation Internet and the Tier III Minus UAV programs.

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Command Control Information Systems EE-21	44,445	47,765	67,300	72,100	76,169	90,034	99,034	99,034	Continuing	Continuing

(U) **Mission Description**: Recent military operations, e.g., Desert Storm and Haiti, demonstrated that current theater command, control, communications, intelligence/information systems, planning and rehearsal systems, and non-lethal weapons capabilities lack the ability to support effective operations in diverse new arenas and scenarios ranging from desert heavy battle to urban areas with large civilian populations. Current capabilities do not provide critical interoperable wide-area communications and fail to provide real-time situational awareness, decentralized battle planning, rehearsal and execution capability, and flexible interfaces. The goals of the programs in this project, described individually below, are to enhance information processing, dissemination and presentation capabilities by inclusion of information concerning enemy and friendly forces, providing a joint situational awareness picture and improved planning and execution support capability (through the Advanced Cooperative Collection Management (ACCM) Program, Joint Forces Air Component Commander (JFACC) Initiatives, Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) and the Advanced Joint Planning (AJP) ACTD); and providing multi-media information interfaces to on-the-move users (through the Speakeasy program). Integration of collection management, planning and battlefield awareness programs is an important element of our strategy for achieving battlefield dominance through information systems. The Command and Control for Joint Early Entry (CCJEE) and the Commercial Communication Technology Testbed (C2T2) programs were refocused into integration and evaluation tasks to support the JFACC program and the AJP ACTD and to link them to BADD.

(U) Elements of the Local Attack Controller/Multi-Access Intelligence and Nomination System (LAC/MAINS) programs applicable to Joint Air Campaign Planning and prosecution of time-critical targets (described under EE-40) has been refocused to support the Joint Forces Air Component Commander (JFACC) Program. The JFACC program seeks to develop key advanced technologies that will markedly improve the commander's ability to conduct air operations effectively and efficiently. Key technologies include: centrally managed, multi-stage, concurrent plan generation; intelligent strike resource scheduling techniques; dynamic resource reallocation algorithms; adaptive cueing tools; automated information routers; and information tailoring tools. These technologies will be applied to requirements that include: continuous mission planning processes which quickly anticipate and react to emerging targets; full integration of intelligence and operational activities to support strike operations and prioritized target

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nomination; empowerment of cross functional product teams to quickly respond to changes; and proper battlefield knowledge to support activities and decisions at multiple echelons.

(U) Emerging technologies in Command and Control planning promise significant enhancements in operational readiness, planning and crisis response. The Advanced Joint Planning (AJP) ACTD seeks to integrate and install selected advanced planning tools, in a distributed collaborative environment at US Atlantic Command (USACOM), to evaluate the potential for enhancing Battle Staff Command and Control capabilities. Based on the evaluation results of this selected subset of planning tools, a full set of tools will be integrated into the USACOM Battle Staff Planning System. This "leave behind" system will form the model for upgrades to other CINC's Planning Systems.

(U) A new generation of collection systems will provide dramatically increased volumes of higher fidelity data to the operational decision maker. The challenge will be to dynamically manage and synchronize this advanced collection architecture with the processing, exploitation, and dissemination capabilities to provide the critical information to the decision maker in the constantly changing operational situation. The conventional requirements management, tasking, collection, processing, and exploitation process is unable to support the dynamics of a constantly changing operational environment. The Advanced Cooperative Collection Management (ACCM) Program will develop Continuous Asset Planning, Automatic Tasking, and Multi-asset Synchronization capabilities which will provide the collection management tools required to dynamically optimize/synchronize, schedule, and task the spaceborne, airborne and ground based collection, processing, exploitation and dissemination architecture. Collection Management (CM)-Link will optimize the architecture's capability to effectively support multiple operational users simultaneously by providing all echelons: a common NRT view of the collection environment; current status of collection, processing, exploitation, and dissemination operations; faster than real-time simulations in support of trade-off decisions; and the ability to conduct real-time multi-echelon coordination and shared decision making.

(U) The objective of the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) is to deliver a synchronized, consistent description of the battlespace, allowing the field commander to design or adapt his command and control system to mission needs for effective application of force. The description of the battlespace provided to the warfighters under this ACTD will be tailored to their mission needs by intelligent selection of information to be broadcast and intelligent request (pull) and filtering at the warfighter workstation so that needed information is available. The ACTD focusses on the dissemination of the data required to present a consistent description of the battlespace and will provide the required infrastructure, information management capabilities, user applications and interfaces to intelligently manipulate data products,

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apply commercial direct broadcast technology for wide-band, low-cost dissemination of multi-media information and provide tactical internet services for two-way communications. A set of applications will be included in the ACTD to support the warfighter in the extraction of information about threats and other important aspects of the battlespace from nearby and remote real-time sensor data streams, intelligence sources and stored data bases. BADD will be evaluated through participation in exercises, demonstrations and ongoing pilot services. Funding for the BADD ACTD was also contained in Project EE-40 for FY 1996, and will be consolidated in Project EE-53 in FY 1997.

(U) Speakeasy will demonstrate a software-programmable communication system in a tactical environment. Speakeasy, which operates over the 2 Mhz to 2 Ghz band, provides the capability to implement wireless communications concepts to meet Service requirements. Speakeasy is an open architecture-based, software-programmable communications terminal supporting simultaneous operation on a minimum of six radio frequency waveforms (four programmable channels in addition to ones for the global positioning system and cellular). The program is transitioning to the Services in FY 1998 after an operational demonstration of the system during the Task Force XXI exercise in FY 1997.

(U) Integration of planning and battlefield awareness programs is an important element of our strategy for achieving battlefield dominance through information systems. The Command and Control for Joint Early Entry (CCJEE) and the Commercial Communication Technology Testbed (C2T2) programs have been refocused into integration and evaluation tasks to support the JFACC program and the AJP ACTD and to link them to other programs such as BADD.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Speakeasy: Continued the development of advanced technologies for the Speakeasy multiband, multimode modules in preparation for first incremental capability demonstration in December 1996. This capability was utilized in the Task Force XXI Advanced Warfighting Experiment (AWE) by the 1st Brigade 4th Infantry Division. ($12.0M)
- Advanced Joint Planning (AJP) ACTD: Evaluated metrics of installed planning tools. Based on the results from previously installed planning tools, integrated and demonstrated additional planning tools which resulted in a completed integration of planning tools at United States Atlantic Command (USACOM). Expanded the functionality of systems to crisis response employing map based planning; and evaluated the installed planning tools and associated metrics under operational conditions for future design incorporation.

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Developed integration and test environment for evaluation of operational effectiveness of commander's planning tools. ($16.5M)

- Battlefield Awareness and Data Dissemination (BADD) ACTD: Demonstrated an initial capability that includes Warfighter Associate functions with local databases, filtering on tags, profiles, requests, static/dynamic visualization and video interaction; and Information Dissemination Manager functions with repository, object tagging, and video/data broadcast. Phase II of the program was initiated. BADD is also funded in part under EE-40 (Critical Mobile Targets-Warbreaker) in FY 1996 and will be consolidated into EE-53 (Information Integration Systems) in FY 1997. ($8.0M)
- Strategic Packaging for Single Chip Modules and MCMs developed revolutionary new low cost packaging technology for high pin-count chips and multi-chip modules. ($2.0M)
- Demonstration of interoperability between off-island military resources and island civil forces in response to a hurricane threat. ($5.9M)
- Continued development, test and integration of components of the LAC that were applicable to joint air campaign planning to the JFACC Program (EE-21) and transitioned them into that project. Delivered and transitioned UNIX version of Army Deep Operations System to Army and Marines. Continued development of advanced capabilities, with emphasis on interoperability, for incorporation into new and existing Air Force systems. Enhanced distributed situation object technology and targeting functions to support multimedia databases and target systems analysis. (This program is funded in Project EE-40 in FY 1996 at $9.5M)

(U) <u>FY 1997 Program</u>:

- Speakeasy: Continue development of hardware and software technology for the Speakeasy demonstration radio and participate in Task Force XXI AWE. Transition program to the Services to complete development in FY 1998 and FY 1999. ($5.3M)
- Advanced Joint Planning ACTD: Based on prior year evaluation, complete the design, accomplish modifications and installation of a "leave behind" operational system, which can then be replicated for other CINCs. ($15.7M)
- Joint Forces Air Component Commander (JFACC): Demonstrate prototype components of the continuous planning process: air operations resource allocation and scheduling tools, campaign assessment process, workflow management control of the planning process, ISR and logistics planner, target system analysis toolset. ($26.8M)

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(U) FY 1998 Program:

- Initiate Advanced Cooperative Collection Management (ACCM) Program Phase 1 with multiple competitive system designs and technology development efforts. Phase 1 capability development will focus on the Dark Star, U-2R and a national platform. Phases 2 and 3 will expand to other UAVs, national and theater assets. Downselect at the end of Phase 1. ($10.0M)
- Complete the transition and support to the operational Advanced Joint Planning System to USACOM. ($1.3M)
- JFACC: Demonstrate continuous planning process management supported by collaboration. Demonstrate integrated planners for force application, force enhancement, force support and aerospace control air operation resources. ($31.0M)
- JFACC Interoperability: Demonstrate a common, objectives-based, campaign strategy development process using common tools and linked processes between echelons - Joint Force Commander (JFC) and JFACC. Support common planning processes with GCCS LES-type anchor desks and services. ($25.0M)

(U) FY 1999 Program:

- ACCM: Demonstrate initial proof-of-concept of Continuous Asset Planning, Automatic Tasking, Multi-Asset Synchronization and CM-Link in the Roving Sands 99 exercise. ($12.0M)
- JFACC: Demonstrate the initial continuous planning process that anticipates and quickly reacts to battlefield situation updates. Demonstrate within a distributed, multi-service planning environment supported by collaborative services. ($33.1M)
- JFACC Interoperability: Demonstrate the application of the JFACC planning aids and process to the Maritime domain. Tailor the integrated strategy development and plan generation tools to Maritime operations objectives and resource management. ($27.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	61.4	47.8	57.3	62.1
Appropriated	55.0	N/A	N/A	N/A
Current Budget	44.4	47.8	67.3	72.1

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(U) **Change Summary Explanation**:

FY 1996 Decrease reflects net effect of: Funding of the Battlefield Awareness and Data Dissemination (BADD) ACTD and transfer of the Military Operations in a Built-up Area (MOBA) to Project EE-51, ($-7.7 million); rescission of small satellite program ($-1.0 million); and inflation savings on DD-1415 reprogramming actions ($-1.9 million).

FY 1998-99 Increase reflects funding of the Advanced Cooperative Collection Management (ACCM) Program.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Demonstrate baseline LAC functionality within USAF Combat Integration Center (CIC) at Roving Sands 96.
Jul 96	Expand the AJP-ACTD functionality of systems to crisis response.
Aug 96	Deliver initial BADD capability to 4th Infantry Division.
Sep 96	Evaluate the installed AJP-ACTD planning tools and associated metrics under operational conditions.
Dec 96	Demonstrate Speakeasy Model Year 1 initial capability in preparation for Task Force XXI Advanced Warfighting Experiment (AWE).
Jan 97	Demonstrate initial objectives-based targeting module for JFACC.
Mar 97	Support Task Force XXI Advanced Warfighting Experiment.
Sep 97	Complete the design, accomplish modifications and installation of "leave behind" AJP-ACTD operational systems.
Jun 98	Demonstrate prototype JFACC planning and execution infrastructure/tools.
Jun 98	Demonstrate integrated strategy development and plan generation functionality for JFACC.
Sep 98	Demonstrate JFACC - JFC Interoperability.
Apr 99	Demonstrate proof-of-concept ACCM capabilities in Roving Sands 99.
Jun 99	Demonstrate initial continuous planning system for JFACC.
Sep 99	Demonstrate JFACC Interoperability using a common planning process and aids for Maritime planning.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Aerospace Surveillance Technology EE-27	3,000	0	17,000	14,000	12,000	16,200	25,000	27,000	Continuing	Continuing

(U) **Mission Description:** This project funds space and airborne sensor efforts whose purpose is to improve the accuracy and timeliness of our surveillance systems for improved battlefield awareness. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces the tactical information needed to succeed in future wars. This operational surveillance capability must perform during enemy efforts to deny and deceive the sensor systems, and operate, at times in a covert manner. In addition, two very important emerging military capabilities call for high-density, high-accuracy Digital Terrain Elevation Data (DTED): these are Battlefield Visualization (BV) and geo-referenced Precision Guided Munitions (PGM). This project will exploit recent advances in signal processing, low-power high-performance computing, and low-cost micro-electronics to develop advanced surveillance systems.

(U) The Digital Terrain Mapping System will provide the capability to map terrain and provide high-density, high-accuracy DTED. One application, Battlefield Visualization, will receive DTED with a one meter post spacing and a relative accuracy of less than one meter. The other emerging capability, geo-referenced PGMs, require WGS-84 target location errors (TLE) of approximately 10 meters today and will require TLEs of 1-to-3 meters with the next generation. Target geolocation at these levels, a capability not currently available, is best accomplished by correlating a DTED database with near-real-time 2-D radar or EO reconnaissance data. Optical and radar techniques will be developed, evaluated and characterized for their relative merits. This project will develop an affordable airborne capability before the end of the decade that will accomplish three important things: 1) evolve the thinking of BV and PGM users by participation in military planning, exercises, and Bosnia-like operations; 2) produce the needed data products in accessible areas of the world; and 3) resolve many of the technology issues that will be faced by a future operational space-based system.

(U) The Passive Radar Tag for Covert Communications will provide a covert capability to remotely extract data from unattended ground sensors and Special Operation Forces (SOF) in real-time by sensors such as the Joint STARS or ASARS surveillance radar systems. Miniature prototypes have already been developed for other radars such as the APS-137 and APS-145 used on the E2-C and P3. The tags will use special wake-up circuitry, surface acoustic wave delay lines,

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and modulation techniques to detect, delay, and modify radar pulses from these radars such that the return pulse received by the radar will include unique identification numbers and data messages from the tag. The interrogating radars will be modified to detect, identify, and display the tag message. Variants of the tag will be produced to be compatible with air delivered internetted ground sensors and with manportable tags used by Special Operation Forces (SOF) units.

(U) A Synthetic Aperture Radiometer will be developed which will provide timely, all weather, day-night, high resolution passive imaging from space and airborne platforms. The applications include: measurement of military, meteorological, and environmental phenomena; and navigation, surveillance, and targeting from low observable platforms. This project will develop a prototype that will be flight tested on an aircraft. It will also serve as the basis for integration as a payload on a space based platform. Potential cost and performance advantages derive from the ability to cover large fields of view without the need for the large amounts of power required by conventional synthetic aperture radar, and by using highly thinned array antennas.

(U) A Very Low Earth Orbit Synthetic Aperture Radar (VLEO SAR) will be developed that can provide an affordable, all weather high resolution (1m) imagery from low earth orbit spacecraft. This system will serve as the prototype for a constellation of LEO spacecraft that can provide high revisit rates (1 per 15 minutes) over target areas. The system will feature lightweight deployable antennas, opto-electronic direct radio frequency (RF) synthesizers, and high bandwidth optical communications. Imagery will be downlinked to a theater ground station.

(U) In FY 1996, the Congress funded a Large Millimeter Wave Telescope as a potential joint United States/Mexico program to build and operate an adaptive, high precision, wide bandwidth, 50-meter aperture millimeter wave radio telescope. The sites being considered in Mexico offer low humidity and the ability to view both northern and southern skies. This telescope is being designed for a 5 microradian pointing accuracy, which, if achieved, would better the current state-of-the-art for radio telescopes.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Developed baseline optical design for the Large Millimeter (MM) Wave Telescope Program. Completed preliminary design review for all antenna systems and radome for the Large MM Wave Telescope Program. ($3.0M)

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(U) FY 1997 Program: N/A

(U) FY 1998 Program:

- Initiate system study to determine the ultimate utility and appropriate platform for the deployment of the Synthetic Aperture Radiometer. This will include, but not be limited to satellite, aircraft and lighter-than-air platforms. Once the application has been defined, a development program will be initiated to demonstrate the performance of a system. In the development program, a ground based, proof-of-concept, breadboard system will be constructed. Analytic performance models will be verified to allow accurate system estimates in a variety of scenarios. ($6.6M)
- Initiate development of precision aircraft attitude measurement system and specialized data processing algorithms for the Digital Terrain Mapping Program. ($5.0M)
- Perform concept analysis, perform system design, and initiate fabrication on the Passive Radar Tags for Covert Communications Program. Initiate development program to miniaturize tags using technology developed under previous DARPA programs. ($3.4M)
- Perform concept study and preliminary system design for a Very Low Earth Orbit Radar. Select vehicles for technology demonstration evaluation and operational phases of program. Initiate development of critical components for antenna, signal processing, and communications subsystems. ($2.0M)

(U) FY 1999 Program:

- Complete development and testing of precision aircraft attitude measurement system and data processing algorithms for Digital Terrain Mapping system. Demonstrate system, evaluate performance, and transition to user for further engineering and production. ($1.9M)
- Complete fabrication, and develop test and evaluation plan for the Passive Radar Tags for Covert Communications. ($2.1M)
- Initiate development of a complete demonstration system of the Synthetic Aperture Radiometer. The development system will be flown using an aircraft platform to demonstrate the system capabilities against targets of military interest. Tests will be conducted in adverse weather and with typical background terrain to fully demonstrate the Radiometer's capabilities. ($7.8M)
- Initiate system engineering of space and ground segments of the Very Low Earth Orbit Synthetic Aperture Radar VLEO SAR. Develop specifications for full System development. ($2.2M)

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(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0	0
Appropriated	3.0	N/A	N/A	N/A
Current Budget	3.0	0	17.0	14.0

(U) **Change Summary Explanation**:

FY 1998-99 Addition of the following programs: Digital Terrain Mapping, Passive Radar Tags for Covert Communications, Synthetic Aperture Radiometer, and Very Low Earth Orbit Synthetic Aperture Radar.

(U) **Other Program Funding Summary Cost**: *(In Millions)*

Digital Terrain Mapping

Source	FY96	FY97	FY98	FY99
DARO	2	1.5	2.0	5.0
Services	-	-	-	5.0

Passive Radar Tags

Source	FY96	FY97	FY98	FY99
DARO	3	1.0	1.0	1.0

(U) **Schedule Profile**:

Plan Milestones

Digital Terrain Mapping System.
Jan 98 Test Attitude Algorighms Using Existing Platform.
Mar 98 Attitude Measurement System CDR.
Jan 99 Ground Test Program.

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Apr 99 Flight Test Program.
Radar Tags
May 99 Test Brassboard Tag with Joint STARS Software modification.
Aug 99 Final Flight Test using Brassboard Tag.
Dec 99 Miniaturized Prototype Tag Critical Design Review.
Jul 00 Complete bench test of Prototype Miniaturized Tag.
Aug 00 Initial Flight Testing using Prototype Miniaturized Tag.

Synthetic Aperture Radiometer
Jan 98 Design Review of Ground Based, Breadboard System.
Aug 98 Complete Ground Based System Tests.
Nov 99 Critical Design Review of Airborne Tests and System.
Jul 00 Ground Testing.
Sep 00 Flight Testing of Synthetic Aperture Radiometer.

Very Low Earth Orbit Synthetic Aperture Radar
Oct 98 Concept Study and Preliminary System Design.
Oct 99 Specifications for Full System Development.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Guidance Technology EE-34	11,876	10,499	21,100	21,100	28,112	30,800	35,200	52,000	Continuing	Continuing

(U) **Mission Description:** Fire-and-forget stand-off weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively and with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system (i.e. WGS-84) in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems cooperate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. The achievement of these characteristics in an integrated system is the goal of this program. The advanced navigation and guidance technologies being developed in support of this goal are called the Global Positioning System (GPS) Guidance Package (GGP). GGP technologies are applicable for both new or retrofit guidance/navigation packages for aircraft and weapons. Additional thrusts are included both to improve the robustness of precision navigation and guidance and to apply the technologies to an Advanced Tactical Targeting System.

(U) GGP tightly integrates a miniature GPS receiver and an all solid state, low cost, navigation-grade, interferometric fiber optic gyroscope (IFOG) based miniature inertial measurement unit (MIMU) with an advanced navigation computer into a low cost ($15,000), precision navigation system. GGP Phase I addressed the technology issues involved in: (1) miniaturizing navigation grade inertial measurement units (IMUs) into a compact, manufacturable configuration; and (2) developing a multi-channel-on-chip, high dynamics GPS receiver. A Memorandum of Agreement (MOA) has been signed and implemented to demonstrate a Phase 1 unit on an Army Fire Support Team Vehicle (FIST-V). Successful demonstrations were conducted at Redstone Arsenal in June 1995 using a M981 FIST-V. GGP Phase 2 requirements place more stressing demands on performance of MIMU components and call for further reductions in size, power and weight. An MOA has been signed with the Navy designating GGP Phase 2 as the Navy's Advanced Integrated Navigation and Control Package. Two MOAs are in process. One is with the Program Executive Officer, Tactical Missiles, Army Missile Command. The second is with the Project Manager, Bradley Fighting Vehicle Systems, Army Tank and Automotive Command.

(U) There are two program thrusts to increase the robustness of precision navigation and guidance in warfighting environments. The first, "Pseudolites", will demonstrate the system concept for high power transmitters to enhance

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Global Positioning System (GPS) users ability to mitigate enemy jamming in a region of military operations. The auxiliary pseudolites, or pseudo-satellites, provide strong navigation signals to mitigate the jamming with no change to the existing, worldwide GPS. The second thrust increases robustness of GPS receivers by increasing their ability to operate effectively in presence of jamming or enemy countermeasures. This thrust will provide for the design, development, implementation and demonstration of a low cost, all digitally controlled GPS phased array receiver antenna. Coherent array beam forming and signal processing will be performed with digital circuits, eliminating: (a) costly, precision matched analog antenna components; and (b) antenna recalibration for stressing military environments.

(U) The Advanced Tactical Targeting System (ATTS) will demonstrate a passive tactical targeting system for the lethal suppression of enemy air defenses (SEAD). ATTS's objectives are to develop passive targeting technologies with precision time standards, wideband low cost multichip module based radio frequency (RF) receivers and high gain/wide field of view antennas and to demonstrate an affordable tactical targeting system solution. The SEAD mission must now be accomplished in the face of new electronic order of battle (EOCB) and new engagement tactics by enemy air defenders such as frequent threat emitter shutdowns. Today's targeting systems fail to provide timely information to target the growing mobile threat. Far more comprehensive, near real time, cockpit battlefield awareness must be provided. This includes synchronization of multi-platform information, long range emitter identification and target geolocation within seconds. An order of magnitude improvement in rapid target geolocation accuracy is needed against mobile surface to air missiles. Emerging DARPA technologies can combine to provide an affordable lethal SEAD tactical targeting capability. These include leveraging the GPS Guidance Package and cesium clock technologies for precision time and location. Low cost, light weight RF wideband digital receiver, processor and adaptive antenna functions can be implemented in advanced technology multichip modules.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:
- Continued Global Positioning System (GPS) Guidance Package (GGP) Phase 2 designs. ($10.7M)
- Conducted demonstration of Phase 1 GGP units on a Navy testbed aircraft. ($1.2M)

(U) FY 1997 Program:
- Complete GGP Phase 2 designs and begin fabrication of two competitive GGP units. ($10.5M)

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(U) FY 1998 Program:

- Continue fabrication and begin integration of Global Positioning System (GPS) Guidance Package (GGP) hardware and software. ($10.0M)
- Conduct systems requirements review, design Pseudolite components and develop coordination/networking architectures. ($3.0M)
- Design antenna array, signal processing and control functions for increasing GPS receiver robustness. ($4.1M)
- Initiate Advanced Tactical Targeting System (ATTS) design and development. ($4.0M)

(U) FY 1999 Program:

- Perform final integration and testing of GGP units; deliver eight units. ($4.6M)
- Conduct final design reviews for Pseudolites. ($.5M)
- Fabricate Pseudolite brassboards. ($2.9M)
- Conduct final design reviews for robust GPS receiver antenna and signal processing. ($.8M)
- Fabricate robust GPS receiver antenna. ($5.6M)
- Complete ATTS design and conduct breadboard component demonstrations. ($6.7M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	26.2	10.5	15.0	16.6
Appropriated	12.1	N/A	N/A	N/A
Current Budget	11.9	10.5	21.1	21.1

(U) **Change Summary Explanation**:

FY 1996 Reflects minor repricing.
FY 1998-99 Reflects program repricing to accommodate additional efforts for more robust navigation and guidance and for the Advanced Tactical Targeting System.

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(U) **Other Program Funding Summary Cost**: *(In Millions)*

PE 0305154D	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
Robust GPS	0.2	0.5	1.3	1.6	2.0	1.0	1.0	
Pseudolite	0.2	1.148	1.5	1.4	1.0	1.0	1.0	1.0

(U) **Schedule Profile**:

Plan	Milestones
Sep 96	Complete Government evaluation of Phase 1 GPS Guidance Package (GGP) units on a Navy aircraft.
Jun 97	Conduct GGP Phase 2 critical design review.
Jul 97	Begin fabrication of GGP Phase 2 units.
Mar 98	Begin design of the Advanced Tactical Targeting System (ATTS).
Apr 98	Begin Pseudolite design.
Sep 98	Begin integration of hardware and software for GGP Phase 2 units.
Feb 99	Complete design of the ATTS.
Jun 99	Deliver GGP units to the Government.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Ship-Sensor Systems EE-36	24,314	18,844	20,330	44,096	81,478	89,696	109,696	119,696	Continuing	Continuing

*In FY 1997, this project consolidates programs under PE 0603226E, Project EE-39 and PE 0603569E, Project AS-01.

Project EE-39	(33,901)	(8,897)
Project AS-01	(31,400)	(31,910)

(U) **Mission Description:** The objectives of this project are to develop and demonstrate advanced systems concepts and to pursue critical enabling technologies for maritime systems that will counter the threat created by the world-wide spread of increasingly sophisticated military technology. The evolving threat of quiet diesel submarines, the proliferation of sophisticated submarine and weapons capabilities, and the growing stockpile of underwater mines available to third world countries necessitates the development of far-term solutions for increasing ship affordability and enhancing our operating capabilities in the littoral. This project will provide advanced technologies to enhance the capabilities of naval forces to more effectively operate "...forward from the sea" in a broader range of tactical environments.

(U) The Advanced Ship-Sensor Systems Program includes Sensor and Sonar Technology, Advanced Ship Mechanical Systems, and Advanced Maritime Platforms. In the Sonar Technology area, applications of advanced object detection, classification, and localization technologies using High Performance Computing (HPC) are demonstrated. Active and passive sonar techniques are applied, using advanced sources and sonar systems built from distributed elements or concentrated arrays. Advanced signal processing techniques to integrate real-time information and background intelligence into the operational situation is also included. These applications will result in enhanced Anti-Submarine Warfare (ASW) capability against diesel-electric submarines operating in shallow water. In the Advanced Ship Mechanical Systems area, technologies such as precision active structural controls, actuator and sensor systems and high speed digital signal processing are being developed. These technologies will result in reduced ship acoustic signatures, high performance/high reliability propulsion systems, a safer/more survivable ship, and increase ship system affordability. Advanced Maritime Platforms focuses on the technologies for innovative ships and ship systems to provide the multi-mission, sustained presence capability required for joint operations associated with future regional conflicts. The advanced ASW program addresses coordinated source and receiver concepts to substantially increase the range for reliable detection and classification of quiet submarines. A particular focus is waveform design for optimal noise rejection and enhancement of target echoes.

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(U) Commencing in FY 1997, this project will incorporate programs formerly under the Advanced Submarine Technology Project (AS-01) and the Unmanned Undersea Vehicle (UUV) Project (EE-39). These projects are reported separately in their respective Budget Item Justification Sheets for FY 1995 and FY 1996. Innovative technologies to significantly enhance submarine stealth and survivability including hydrodynamic control, advanced materials/structures, and structural acoustics efforts to reduce ship observables will continue to be developed and demonstrated. They form the basis for efforts addressing affordability through improvements in structural acoustic design capabilities, innovative machinery mounting systems and high reliability propulsion systems. The Supercavitation Technology Program will continue to address the physics of launching and propelling underwater bodies at velocities approaching the speed of sound in water. UUV technologies brought forward involve development of a Synthetic Aperture Sonar (SAS) system to increase underwater search rates for mine detection and classification.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Completed development of multistatic active adaptive processing and impulsive sources for shallow water tactical sonars. Completed assessment of potential of multistatic active adaptive technology. Conducted fleet Anti-Submarine Warfare (ASW) demonstration of multistatic active tactical processor and other components. ($9.0M)
- Accelerated autonomous ASW detection effort and extend to multi-targets and broader application to fleet systems. Deployed and evaluated initial (one class) autonomous submarine detection and classification package. ($3.5M)
- Exploited available wide-swath, mine locating Synthetic Aperture Sonar (SAS) sea test data, investigated potential improvements which can be realized by incorporating state-of-the-art motion compensation. ($.5M)
- Explored stand-alone, low-frequency, acoustic source options for insonification of high interest,littoral waters to support high probability ASW search of these areas. ($.5M)
- Evaluated enhanced torpedo attack phase performance to be realized from fiber optic weapon link to launch platform and initiate planning for feasibility demonstration. ($.4M)
- Performed studies to develop technology options for future surface ships including the initial support activities related to a joint Navy/DARPA program for arsenal ship development. This work led to activities performed under Project EE-47 starting in FY 1997. ($1.0M)

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- The following activities were funded by Congressional additions to the FY 1996 President's Budget:
  - Completed design and assemble off-board autonomous detection and classification package in preparation for demonstration in sea test. ($2.9M)
  - Conducted simulation and modeling of information exchange and potential improvements among fleet platforms, Anti-submarine Warfare (ASW) sensors and other sources to establish a basis for pursuing performance technical enhancement opportunities. ($2.0M)
  - Developed a design and system architecture for an autonomous deployable sensor package suitable for long term monitoring of disposal sites for the Deep Ocean Relocation Program. ($2.5M)
  - Developed design concepts for improved survivability of naval combatants-damage control without direct crew participation. Developed and demonstrated proof-of-concept sensors/sensor network to remotely monitor, assess, and control casualty conditions throughout the ship. ($2.0M)

(U) <u>FY 1997 Program</u>:

- Complete final at-sea ASW demonstration of environmentally adaptive shallow water active sonar technology in conjunction with single/few platform scene generation capability. ($1.2M)
- Conduct tests to determine the effectiveness of supercavitating high speed bodies against fixed targets. ($.8M)
- Complete development of autonomous ASW multi-target detection technology. ($.8M)
- Fabricate and test a prototype active transmission vibration isolation mount. ($4.0M)
- Initiate development of a large scale Electromagnetic Turbulence Control application for at-sea demonstration of drag reduction, maneuvering control, and signature control. ($2.0M)
- Initiate development of the Automated Multistatic Active/Passive Receiver System (AMARS) for littoral surveillance to include an acoustic source, as well as signal processing for enhanced detection and attack performance. ($4.5M)
- Design and initiate the fabrication of a prototype acoustic mine detection and classification system for a large (10 sqnm/hr) area coverage rate. ($3.0M)
- Develop coded waveform processing techniques and perform ocean tests to enhance long range active coherence and towed array detection performance. ($2.5M)

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(U) FY 1998 Program:

- Continue development, plan, and test proof of concept ASW Automated Multistatic Active/Passive Receiver System (AMARS) at sea, incorporating a wide frequency band, autonomous, long duration, leave behind acoustic source, signal processing for enhanced detection and attack performance, and acoustic space-time adaptive processing. ($6.5M)
- Complete fabrication and conduct at-sea testing of a prototype acoustic mine detection and classification system for a large (10 sqnm/hr) area coverage rate. ($3.5M)
- Initiate development of a system for signal exploitation and environmentally adaptive waveform generation. ($6.3M)
- Commence design work that could lead toward at-sea demonstration of Electromagnetic Turbulence Control (EMTC) or other flow enhancements, exploiting potential drag reduction technologies leading to an improved flowfield for a submarine. ($2.9M)
- Develop advanced submarine hydrodynamics and structural designs that are focused toward reducing submarine target strength against active sensor detection. ($1.1M)

(U) FY 1999 Program:

- Upgrade system and demonstrate detection-to-attack performance of a prototype Anti-submarine Warfare (ASW) Automated Multistatic Active/Passive Receiver System (AMARS), incorporating: full wide frequency band, autonomous, long duration, leave behind acoustic source, autonomous diesel electric detection, signal processing for enhanced attack performance, and acoustic space-time adaptive processing. ($7.1M)
- Upgrade system and conduct an at-sea demonstration test of a prototype acoustic mine detection and classification system for a large (10 sqnm/hr) area coverage rate. ($3.2M)
- Continue development of and conduct at-sea testing of a signal exploitation and environmentally adaptive waveform generation system. ($8.3M)
- Develop detail design and test planning for the at-sea demonstration of EMTC or other flow enhancements in a large scale test vehicle. ($15.7M)
- Continue development and demonstrate advanced submarine hydrodynamics and structural designs that are focused toward reducing submarine target strength against active sonar detection. ($9.8M)

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E, Project EE-36

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	16.5	18.8	21.3	62.1
Appropriated	25.4	N/A	N/A	N/A
Current Budget	24.3	18.8	20.3	44.1

(U) **Change Summary Explanation**:

FY 1996 Reflects Bosnia reprogramming ($-.8 million), transfer of sensor systems to the Small Unit Operations, Project EE-51, ($-.8 million), and Arsenal Ship studies ($+1.0 million) and minor repricing ($-.5 million).

FY 1998 Minor program repricing.

FY 1999 Reduction reflects transfer of funds to Project EE-47 for support of the Arsenal Ship Program and restructuring of the following: fabrication and test of a supercavitating gun and high speed torpedo demonstrator, multiple target capilite autonomous detection technology, and synthetic aperture sonar technology enhancement effort.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
4QFY96	Conduct an at-sea demonstration of multistatic active adaptive processing for shallow water tactical sonars.
4QFY96	Conduct proof of concept test for acoustic mine detection and classification system.
4QFY96	Complete Large-Scale Demonstration of advanced Aeroderivative Engine active control technology.
4QFY96	Conduct at-sea demonstration of an autonomous submarine detection and classification system .
4QFY96	Complete preliminary design for a Mobile Offshore Base (MOB) concept.
4QFY96	Demonstrate simulation and visualization techniques of dredged material isolation process.
4QFY96	Complete design concept for survivable naval combatant.

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1QFY97	Complete active transmission vibration isolation mount prototype test.
3QFY97	Conduct functional demonstration of off-board detection and classification sensor.
3QFY97	Conduct laboratory demonstration of signal processing for enhanced detection and attack performance.
3QFY97	Complete development of coded waveform processing techniques and perform ocean tests to enhance long range active coherence and towed array detection performance.
3QFY97	Demonstrate sensors/sensor network proof-of-concept for remote monitoring, assessment, and control of shipboard casualties.
4QFY97	Demonstrate prototype active transmission vibration isolation mount.
4QFY97	Conduct laboratory test of power generation and conversion for an autonomous acoustic source.
4QFY97	Conduct design of acoustic mine detection and classification system.
1QFY98	Complete airframe shake test of active transmission vibration isolation mount.
2QFY98	Conduct Anti-Submarine Warfare (ASW) Automated Multistatic Active/Passive Receiver System (AMARS) proof of concept test.
4QFY98	Conduct initial at-sea test of prototype acoustic mine detection and classification system.
3QFY99	Conduct at-sea test of signal exploitation and environmentally adaptive waveform generation system.
4QFY99	Conduct at-sea test of prototype Automated Multistatic Active/Passive Receiver System (AMARS).
4QFY99	Conduct at-sea test of prototype acoustic mine detection and classification system.

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R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Simulation EE-37	61,040	48,419	32,912	21,798	0	0	0	0	0	N/A

(U) **Mission Description:** The strategic environment in which the United States operates places emphasis on joint crisis response and requires coordinated joint and service training programs to ensure readiness. Resources will continue to shrink, requiring the Department to search for the most cost effective means to address varied threats across the full spectrum of military activity. To support the National Military Strategy, the Advanced Distributed Simulation program is developing advanced simulation technologies to effectively and efficiently construct a seamless synthetic battlespace that will enable fundamental changes in how defense functions are accomplished. The ultimate goal is to create warfighting simulation technologies, capable of representing Joint Forces up to a theater of war, and supporting the following functions: Joint/Service readiness training; Joint/Service doctrine refinement and development; requirements analysis; design and prototyping; and contingency planning. Specific technology efforts being undertaken as part of this project include simulation system design, incorporating the DOD High Level Architecture (HLA); synthetic environment development, synthetic forces development, and, networking and information transfer. As technologies mature, they will be integrated, tested and demonstrated in exercises of increasing size, complexity and utility. These technologies will transition to service and joint simulations, e.g. JSIMS, WARSIM, etc. through tightly coupled transition programs.

(U) The Synthetic Environment Program concentrates on the creation of synthetic environments for simulation including representation of static and dynamic terrain, weather and environmental phenomena, and diurnal variations. The Synthetic Forces Program creates a scaleable, computer-generated military force that is representative and behaviorally accurate with explicit simulation of the C3I systems and the capability of resolving battle outcomes at the weapon system level of detail. The Networking and Information Transfer Technology Development Program investigates and develops the communication, networking and information transfer technologies necessary to take full advantage of capabilities offered by the next generation communication technology. These technologies facilitate efficient and cost effective utilization of evolving network infrastructure while supporting the requirement to represent 100,000 entities interoperating over the network, in either perceptible-real-time or faster-than real-time.

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(U) The Synthetic Theater of War (STOW) program is an integral element of the Advanced Distributed Simulation Technology Program, and has been designated an Advanced Concept Technology Demonstration (ACTD). STOW is developing the HLA compliant simulation system design which will enable the integration of simulation technologies to create a seamless synthetic battlespace to support joint training and mission rehearsal.

(U) The Operational Simulation Technology Program develops simulation technology and integrates it with real-world planning and command and control systems. As a result of this program simulation will act as a bridge to real-world battlespace C2 by enhancing the commander's ability to analyze courses of action, evaluate outcomes, and rehearse mission plans.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Developed and demonstrated improved network technologies supporting interaction of 10,000 entities within the HLA compliant simulation operating system. Tested and integrated NSA developed, ATM based, network security devices. ($3.4M)
- Improved and demonstrated the technology necessary to create a synthetic battlespace to include increased fidelity of terrain and environmental effects (e.g. fog, smoke, haze); continued development of terrain and environmental data bases to support STOW 1997. Initiated efforts to transition to a HLA compliant system. ($6.1M)
- Developed synthetic, artificially intelligent, command entities; expanded development of synthetic forces to include representations of additional battlespace entities for all services. Improved functionality of existing synthetic forces. Developed and tested a set of standard interface specifications capable of accommodating a variety of technical architectures which represent service unique command and control features. Initiated efforts to transition to an object oriented, HLA compliant subsystem architecture. ($23.1M)
- Developed a STOW simulation operating system, tested and integrated technologies, and continued development of the STOW Advanced Concept Technical Demonstration (ACTD) prototype simulation for the STOW-97 ACTD. ($19.9M)
- Continued development of advanced simulation technologies to include initial use of automatic code generation to create synthetic forces from high level specifications; designed next generation simulation infrastructure to support faster-than-real-time, variable fidelity synthetic forces; and initiated

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development of semi-automated scenario setup. Higher level behaviors of synthetic forces, faster-than-real-time simulation, and improved efficiencies for generating simulations. ($4.3M)

- Demonstrated the capability to utilize concurrent engineering tools for land vehicle design, link to synthetic battlefield environments, and tie requirements to design through virtual prototypes. ($4.2M)

(U) FY 1997 Program:

- Integrate and test expanded HLA compliant network and information transfer various technologies and network security devices. Demonstrate these technologies for the STOW 1997 ACTD. ($1.5M)
- Continue to develop and transition HLA compliant synthetic environment technology. Continue development of environmental technologies capable of supporting an environmentally robust battlespace to include interactive terrain, battlefield obscurants, diurnal effects. Develop technology for simulating the full range of dynamic terrain effects, e.g. cratering, building positions, fighting. ($5.3M)
- Continue to develop and transition a broad range of synthetic forces representing combat elements; integrate with the DoD HLA a distributed command and control structure portraying in simulation the influence of one command level on the actions of the subordinate synthetic formations. Continue to develop and demonstrate increasingly more sophisticated behaviors representing an extended set of battlespace reactions such as situational awareness, reaction to the environment and tactical planning. Continue to re-architect synthetic forces to an object oriented, HLA compliant design. ($13.7M)
- Demonstrate and transition a prototype Joint Synthetic Theater of War simulation system supporting a seamless land/sea/air warfighting synthetic environment capable of representing up to 50,000 entities with a high degree of realism, supporting Service and joint operational training while retaining the arbitration of battle outcomes at the entity level of detail. ($12.3M)
- Create an integrated simulation environment capable of supporting rapid course-of-action analysis for a single service, using automated, faster-than-real-time (FTRT) battle simulation, with both friendly forces and reactive OPFOR. Integrate this simulation environment with multi-dimensional analysis tools to enable rapid review of courses of action developed as part of mission planning. ($15.6M)

(U) FY 1998 Program:

- Continue to develop, in a series of USACOM sponsored exercises, the prototype STOW simulation. Integrate new/improved synthetic environments, synthetic forces, and networking technologies as they become available. ($12.8M)

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- Demonstrate an integrated software package with the following capabilities: Adaptive Synthetic Forces; a 5 fold decrease in time required to setup an exercise; interactive integration of simulation with operational systems; and an ability to use simulation to support rapid mission rehearsal and rapid replanning. This effort supports and is fully coordinated with the Joint Simulation Program. ($20.1M)

(U) FY 1999 Program:

- Continue to develop, demonstrate, and transition prototype technologies supporting a DoD High Level Simulation Architecture Compliant Joint Synthetic Theater of War Simulation System. Demonstrations will continue to focus on the representation of a seamless land/sea/air warfighting synthetic environment with an ever increasing degree of realism, supporting service and joint operational training and retaining the arbitration of battle outcomes at the platform level. ($11.6M)
- Provide a warfare commander with projections of the emerging battlespace through use of real-time battlefield monitoring, rapid course-of-action analysis, higher echelon faster-than-real-time (FTRT) battle simulation. Expand battlefield simulation represention of both friendly forces and reactive OPFOR. Develop automatic alerts and critical path detection tools. Prototype a real-world-data feed integrated with simulation. Complete technology transition to DoD simulation programs. ($10.2M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	79.1	48.4	42.3	44.7
Appropriated	66.1	N/A	N/A	N/A
Current Budget	61.0	48.4	32.9	21.8

(U) **Change Summary Explanation**:

FY 1996 Reflects inflation savings ($-.6 million), reductions to the core simulation technologies development program ($-3.6 million), and transfer of SBIR set aside to PE 0605502E ($-.9 million).

FY 1998-99 Reflects repricing of Operation Simulation technology development.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Sep 96	Demonstrate and assess the capability of concurrent-engineering tools for land vehicles design using engineering work stations, the driving simulator, and the synthetic battlefield
Sep 96	Demonstrate advanced network technologies to include dynamic multicasting.
Jan 97	Conduct technical Engineering Demonstration #2 of integrated STOW Technologies.
Nov 97	Demonstrate ICW USACOM the STOW-97 ACTD Synthetic Theater of War representing a Joint Task Force through a combination of virtual and constructive simulation with a high degree of realism and with outcomes arbitrated at the entity level of detail, for the purpose of mission rehearsal and training.
Nov 97	Demonstrate a simulation environment capable of supporting rapid course of action analysis for a single service, using automated, faster-than-real-time (FTRT) battle simulation (10X), with integrated multi-dimensional analysis.
Nov 98	Demonstrate and integrates real-world database feeds for simulation initialization and updating with automated assessment tools that use simulated projections to provide cues desired by the Commander. Prototype rapid simulation setup.
Nov 99	Demonstrate a simulation environment that provides the Commander with a projection of the emerging battlespace through integration of simulation with real-time battlefield monitoring, improved faster-than-real-time simulation (100X), alerts, critical event detections, and course of action analysis.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Unmanned Undersea Vehicle Systems (UUV) EE-39	15,234	0	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** The growing stockpile of underwater mines and the proliferation of weapons of mass destruction worldwide present a threat in both littoral warfare and strategic warfare situations. The objective of this project is to develop and demonstrate autonomous maritime systems and technologies to counter these threats. The Unmanned Undersea Vehicle (UUV) Program includes efforts in mine countermeasures (MCM) and enabling technologies for autonomous vehicles. In the MCM area, the Autonomous Minehunting and Mapping Technology (AMMT) Program is developing technologies to support Navy clandestine mine warfare requirements that will enable the autonomous location and classification of mines with sufficient precision for detailed minefield mapping and subsequent reacquisition by a neutralization system. The program is also evaluating Synthetic Aperture Sonar (SAS) to increase underwater search rates in support of mine countermeasures. For UUV enabling technologies, an Aluminum Oxygen Semi-cell is being developed as a high energy density power system to provide the range and endurance required for longer UUV missions. These efforts are coordinated with and support the long-range goals of the Navy UUV Program Plan. In FY 1997, this Project is merged with EE-36, Advanced Ship/Sensor Systems.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Completed at-sea testing of Autonomous Minehunting and Mapping Technology (AMMT), including navigation and mapping, imaging, acoustic communications and mission control. ($5.2M)
- Completed full scale testing of the high energy-density aluminum-oxygen semi-cell UUV power system. ($1.0M)
- Completed simulator and design for liquid fuels for the DOE 2 MW direct molten carbonate fuel cell power plant. ($7.0M)
- Completed proof of concept/feasibility testing of long range Synthetic Aperture Sonar for underwater mine detection and classification. ($2.0M)

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(U) FY 1997 Program: N/A

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	16.8	0.0	0.0	0.0
Appropriated	23.2	N/A	N/A	N/A
Current Budget	15.2	0.0	0.0	0.0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming ($.5 million), reprioritizing of programs resulting in the cancellation of the TAG Delivery System program ($-1.7 million), and consolidation of SWO funds in EE-51 ($5.5 million).

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
May 96	Complete full scale testing of Aluminum Oxygen Semi-cell power system.
May 96	Complete at-sea testing of Autonomous Minehunting and Mapping Technology.

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Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Critical Mobile Targets (WAR BREAKER) EE-40	110,683	0*	0	0	0	0	0	0	0	N/A

*Programs continue in Projects EE-21, EE-50, EE-51 and EE-53.

(U) **Mission Description:** Prosecution of time-critical fixed and mobile targets has long been a concern of the Services as evidenced by past efforts in the areas of Strategic Relocatable Targets and Smart Weapons. Experience in Desert Storm dramatically demonstrated our inability to prosecute these targets, particularly Tactical Ballistic Missile (TBM) launchers. DARPA's WAR BREAKER program has served to develop advanced technology and systems that enable the detection, identification and prosecution of a wide range of high value, time-critical fixed and mobile targets, and has served as the framework for maturing and integrating these technologies for demonstration of systems concepts supporting the prosecution of these targets.

(U) Recently, DARPA has become increasingly active in Advanced Concept Technology Demonstrations (ACTDs) that relate to Battlefield Dominance; that is, providing the field commanders with a comprehensive awareness of the surrounding battlespace and the ability to exploit that information so that force can be brought to bear where it is needed. To enhance the achievement of these capabilities, a major portion of DARPA's efforts, including WAR BREAKER, have been refocused. Through this refocussing, the elements of WAR BREAKER have been transitioned to programs contributing to Battlefield Dominance, including: 1) the Joint Forces Air Component Commander (JFAAC) program (described in Project EE-21) designed to mature battle management, execution and information distribution technologies for enhancement of joint force air operations; 2) the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) described in Project EE-53 that will combine correlation, fusion and infrastructure technologies to enable wideband information dissemination; 3) the Dynamic Multi-User Information Fusion program described in Project EE-53 that will develop the Fusion and correlation tools and technologies for insertion into BADD; and 4) the Semi-Automated Imagery Processing ACTD in Project EE-50 that includes advanced automatic target detection and recognition, automated imagery exploitation, and force recognition efforts. This refocusing is being initiated during FY 1996 and is scheduled to be completed during FY 1997.

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(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Consolidated elements of Intelligence Correlation (IC), Terrain Feature Generation (TFG), and Multi-Access Intelligence and Nomination System (MAINS) applicable to intelligence and information fusion into a Dynamic Multi-User Information Fusion (DMIF) project to develop and evaluate a prototype operational system that amalgamates diverse sensor observations and rectifies disparate fusion products to assist in providing the warfighter a consistent and robust awareness of the battlefield. ($19.9M)
- Continued development, test and integration of components of the LAC that were applicable to joint air campaign planning to the JFACC Program (EE-21) and transition them into that project. Deliver and transition UNIX version of Army Deep Operations System to Army and Marines. Continue development of advanced capabilities, with emphasis on interoperability, for incorporation into new and existing Air Force systems. Enhance distributed situation object technology and targeting functions to support multimedia databases and target systems analysis. ($9.5M)
- Developed and test a GeoSAR airborne, radar-based foliage penetration/terrain elevation and feature mapping system, with an emphasis on both defense and civil applications. ($9.8M)
- Continued those elements of the IC program that, when integrated with the Global Broadcast System, will facilitate dissemination to the warfighter of information about the battlespace in which he is engaged. This Battlefield Awareness and Data Dissemination (BADD) ACTD will demonstrate an initial capability of an Information Dissemination Manager with functions that include repository, object tagging and video/data broadcast, and a Warfighter Associate with functions that include local databases, filtering on tags, profiles, requests, static/dynamic visualization, and video interaction. BADD is also funded in part under EE-21 (Command and Control Information systems) in FY 1996 and is consolidated into EE-53 (Information Integration Systems) in FY 1997. ($7.6M)
- Initiated an ATR Applications project in collaboration with the Defense Airborne Reconnaissance Office (DARO) that incorporates the continued development of Topsight, Monitor and Clipping Service enhancements for integration into the Semi-Automated Imagery Processing (SAIP) ACTD as future capability upgrades. ($2.7M)
- Continued development of MSTAR infrastructure and baseline algorithm suite for an increased number of targets modeled and hide states. ($15.6M)
- Completed algorithm development and hardware modifications for Moving Target Exploitation (MTE), formerly called Dragnet, classification application demonstration. ($6.3M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies,
PE 0603226E, Project EE-40

- Based on data analysis and system design of a UHF/VHF FOPEN sensor, initiate the development of FOPEN technology to provide significant enhancement of the military's capability to detect obscured targets hidden under natural and artificial camouflage and demonstrate the technology with other sensors on board an Endurance UAV in a counter Camouflage, Concealment and Deception (CC&D) ACTD to begin in FY 1997. ($5.6M)
- Initiated the Semi Automated Imagery Exploitation (SAIP) ACTD, in collaboration with the DARO, by integrating technologies developed under MONITOR, TOPSIGHT, Clipping Service, Terrain Feature Generation, Intelligence Correlation, and RADIUS (ST-11) into a system of semi-automated image analyst tools with the capability to process SAR and other image types more completely and correctly, perform wide area search for GOB and MOB targets, perform rapid site monitoring and modeling, and produce target reports in near-real-time. A baseline system was demonstrated at Edwards AFB using ASARS-II data. ($33.7M)

(U) FY 1997-99 Program:

- Description of the FY 1997 refocused WAR BREAKER programs can be found in: JFACC Initiative, Project EE-21; SAIP ACTD, ATR Applications, MSTAR, MTE, and FOPEN, Project EE-50; IUGS, EE-51; and BADD ACTD and DMIF, Project EE-53.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	117.8	0	0	0
Appropriated	110.6	N/A	N/A	N/A
Current Budget	110.7	0	0	0

(U) **Change Summary Explanation**:

FY 1996 Adjustments reflect minor repricing.

(U) **Other Program Funding Summary Cost**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Experimental Evaluation of Major Innovative Technologies, PE 0603226E, Project EE-40

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Demonstrate baseline LAC functionality within USAF Combat Integration Center (CIC) at Roving Sands 96.
Jun 96	Complete benchmark tests of FOPEN ATD/C algorithms.
Aug 96	Laboratory demonstration of SAIP baseline system at Lincoln Lab.
Aug 96	Demo data compression/screening techniques for SAIP in a lab environment (ATR Applications).
Sep 96	Complete integration of DMIF testbed for system design, concept of operations and human computer interface development.
Sep 96	Complete Concept design for FOPEN radar demonstrator.
Sep 96	Completion of transition of War Breaker elements to other projects. FY 1997 and out year milestones appear in recipient projects.
Sep 96	Demonstrate Battlefield Awareness and Data Dissemination (BADD) capability in JWID 96.
Nov 96	First demonstration of MSTAR ATRs: 10 targets, limited Extended Operating Conditions (EOCs).

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RDT&E, Defensewide
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R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Air Defense Initiative EE-41	25,564	21,777	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** Air Defense Initiative (ADI) programs form a critical part of the DARPA program to provide a defense against cruise missiles and manned aircraft. The programs also complement systems being pursued by other program offices to counter theater ballistic missile threats. The rapid evolution and spread of cruise missile systems and technologies require new approaches and technologies to ensure effective and efficient countering of future airbreathing threats to assets in regional theaters.

(U) The DARPA Mountain Top Program provides a cost effective ground-based radar system for the advancement and evaluation of concepts and technologies required for future airborne surveillance radars. Through robust data collection and analysis campaigns, the Mountain Top Program identifies and quantifies natural and man-made phenomenology that may limit Airborne Early Warning (AEW) system performance. Central to this activity is the Radar Surveillance Technology Experimental Radar (RSTER), located at the Pacific Missile Range Facility (PMRF), Kauai, Hawaii. In FY 1996, the Mountain Top Project was divided into the RSTER hardware program segment and the signal processing and analysis effort. The RSTER system continues to serve as the focal point for the Mountain Top Program and program activities continue to concentrate on joint testing and integration to effect a successful RSTER system transition to the Navy by FY 1998.

(U) Advanced Signal Processing Program includes the Common Research Environment for Space Time Adaptive Processing (STAP) Technology (CREST), Algorithm Development Tool (ADT) set designs, signal processing and analysis, and algorithm development and evaluation. The program objective is to positively impact selected Service air defense platforms, specifically the Navy E-2C Hawkeye and the Air Force E-3 Airborne Warning and Control System (AWACS), by providing a focused effort to develop, test, and integrate advanced STAP and selected related algorithms. The Maui High Performance Computing Center (MHPCC) will continue to provide a vast computational resource for multiple technology efforts, including advanced algorithm development, signal processing, and Electromagnetic (EM) signature modeling.

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(U) The Simulation (Transition Support) Program conducts integrated analysis, modeling, simulated exercise, and demonstration efforts to develop Advanced Air Combat Concepts (A2C2) using DARPA technologies and to facilitate technology transition to the Services. Analysis and modeling efforts will be performed to develop and refine employment architectures and concepts of operations (CONOPS) utilizing DARPA technologies. In addition, selected portions of warfighting concepts will be demonstrated to validate key capabilities of DARPA technologies. Field demonstration scenarios will be derived from the analysis and modeling effort, combined with simulated exercises to facilitate operator involvement early in the process.

(U) The AIRMS Program is a large, precision infrared sensor flown on a modified Boeing 720B aircraft that is collecting high quality, long range infrared imagery for advanced air defense applications. AIRMS possesses far better sensitivity, resolution, stabilization, and pointing accuracy than any other airborne infrared asset within the science and technology community today. The AIRMS sensor has flown sixty-three missions over the last two years, collecting over a terabyte of superb quality infrared imagery. Low observable aircraft, cruise missiles, and tactical ballistic missiles have been detected and tracked at ranges exceeding 500 kilometer.

(U) The Crown Royal program will develop and test techniques for spoofing surveillance radars. Off-board intelligent jamming techniques will be evaluated which blind the surveillance radar to the presence of an incoming threat. The support jammer knows the location of the insertion platform it is supporting and uses this information to spoof the enemy air defenses.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- The Mountain Top Program's RSTER system was employed as the surveillance sensor for the Navy's Cruise Missile Defense (CMD) Advanced Concept Technology Demonstration (ACTD) Phase I Live Fire demonstration at the Kokee site at PMRF. DARPA initiated action to formally transfer custody of the RSTER asset to the Navy in support of the E-2C Radar Modernization Program (RMP). The RSTER system was relocated to Makaha Ridge, PMRF in support transition of the asset to the Navy. ($5.0M)
- The Advanced Signal Processing Program established close relationships with multiple Service AEW platform programs including the E-2 and E-3 program offices. The program commenced requirements definition with the selected Service program offices and support activities for direct insertion of cost effective STAP and related adaptive algorithm solutions for air defense. Rome Laboratory released version 1.0 of the Algorithm

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Development Tool and the Maui High Performance Computing Center hosted the virtual STAP Algorithm Development Support Environment. ($6.6M)

- The Simulation (Transition Support) Program continues to conduct architecture studies related to cruise missile defense (CMD) and to monitor and support outside activities of particular interest to DARPA; the J-8 Joint CMD Study, Service architectures, simulation exercises, small wargaming exercises and cost analysis efforts were emphasized. Architecture work continued in three primary areas: assessing advanced fire control benefits for fighters, Navy ADSAM architectures, and aerostat architecture analysis. ($3.9M)
- The AIRMS final data collection campaign has been completed, having collected data against Low Observable aircraft at ranges greater than 500 KM, Cruise missiles at ranges in excess of 110 KM, and TBM's tracked at 350 KM. Over 1 Terabyte of data was cataloged, archived and is on-line at NAWC-CL. In addition, numerous performance models were validated (rework/phenomenology/IRST operational performance), advanced 3-D signal processing was demonstrated, and program work was successfully transitioned into numerous other infrared technology programs. DARPA is assisting the transition through technology transfer of the signal processing activities for the Navy Shipboard IRST program, the AWACS EAGLE program, and the Navy F-14D IRST program. ($5.1M)
- The Crown Royal program developed algorithms for selectively blinding hostile surveillance radars. These algorithms were tested on an existing Air Force testbed. A demonstration plan was developed to employ this novel jamming technique to blind enemy air defenses to the presence of an incoming threat. ($5.0M)

(U) <u>FY 1997 Program</u>:

- The Mountain Top Program will be completed with the transfer custody of the RSTER asset to the E-2C Program Office. ($5.0M)
- The Advanced Signal Processing Program will employ the virtual STAP Algorithm Development Support Environment at MHPCC to design and develop advanced STAP algorithms compatible with the E-2 and E-3 AEW radar systems. The program will be completed in FY 1997 with the successful transition of insertion-ready STAP algorithms for the E-2 and E-3. ($9.8M)
- The Simulation (Transition Support) Program for FY 1997 will focus on the development planning for an F-16 Silent Fighter Demonstration, an F-18 Demonstration of advanced sensor support for Navy fighters, an Advanced Combat ID demonstration, a Joint Strike Fighter (JSF) Architecture study, continued test planning & support for TACSSF advanced sensor utility for fighter operations, and joint testing and support of the Navy WALEX (CONOPS). ($7.0M)

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(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	23.5	21.8	18.6	20.5
Appropriated	27.6	N/A	N/A	N/A
Current Budget	25.6	21.8	0	0

(U) **Change Summary Explanation**:

FY 1997 The ADI program will be transitioned to the Services and other DARPA programs, eliminating the need for future funding.
FY 1996 Decrease reflects reprioritization of requirements.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mountain Top Program:	
Oct 96	MOA between DARPA and Navy signed.
Oct 96	Completion of DARPA Mountain Top Program.
Advanced Signal Processing Program:	
Oct 96	STAP Algorithm Development Support Environment remote access established.
Dec 96	E-2 nd E-3 sensor system algorithm requirements defined.
Aug 97	Complete test and evaluation of candidate algorithms.

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Sep 97 Transition algorithms to E-2 and E-3.
Sep 97 Completion of DARPA Advanced Signal Processing Program.

Simulation (Transition Support) Program:
Apr 96 Seminar Wargame
Jun 96 J-8 JCMD IPR
Sep 96 TACSSF Exercise
Jan 97 Joint Test
Mar 97 F-16 Field Demonstration
May 97 Service Exercise
Sep 97 Joint Architecture Assessment

AIRMS Program:
Program transitioned by FY 1997

Crown Royal:
Jun 96 Develop and test algorithms for blinding hostile radars.
Sep 96 Develop a demonstration plan.

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R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Global Grid Communications EE-45	42,807	42,024	43,392	43,916	44,750	49,549	54,549	49,549	Continuing	Continuing

(U) **Mission Description:** This program develops and demonstrates advanced communications technologies needed for defense and intelligence operations for the 21st century. The program will develop advanced information processing concepts to support a geographically dispersed staff for crisis management. Services for an enhanced information infrastructure to support command and control will be developed and demonstrated to be applicable to advanced, high performance networks. This program will demonstrate that commercial communications resources and technologies can be integrated with advanced optical components developed in this program as well as DoD tactical and satellite technologies developed elsewhere.

(U) The key elements are: 1) Applications such as intelligent decision aids, that enable a geographically distributed planning staff to develop and analyze a course of action; 2) Advanced services such as scalable file systems, databases, and distributed computing support that are integrated with high performance computing, and free applications from the necessity to work down to the raw data transport level; 3) Demonstration networks that validate the research and development and enable early application development and technology transition into DoD efforts such as Defense Information System Networks; 4) Develop network controls pertaining to management, and security software technologies to enable sensor-to-shooter applications combining all network media; and 5) Develop advanced optoelectronic network component technology and network architecture for scalable and modular networks. The aggregate network bandwidth will be in the range of terabits per second and the network will handle multi-media service for both digital and analog signals.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Demonstrated evolving software development practices and the migration of software applications and information services to higher bandwidth networks in an operational exercise involving multiple JTFs. ($17.0M)
- Demonstrated integration on a CONUS/International scale of all networks and demonstrate end-to-end secure transmission and signaling at gigabit rates. ($4.9M)
- Demonstrated high bandwidth operation of critical multi-wavelength components. ($7.3M)

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- Field tested local area network application of multi-wavelength analog and digital signal transmission. ($8.7M)
- Developed multi-wavelength network management software and control algorithms. ($4.9M)

(U) FY 1997 Program:
- Identify control and protocol issues for operation of multi-wavelength networks. ($4.2M)
- Demonstrate advance integrated optoelectronic network component operations. ($9.4M)
- Complete multi-wavelength network architecture and control planning; and initiate field-trial network deployment for long-distance and wide area applications. ($14.4M)
- Demonstrate integration with advanced testbeds; large scale planning demonstrations; and deployable JTF C3 (mobile C3, plan rehearsal and refinement during deployment, intelligent interfaces). ($14.0M)

(U) FY 1998 Program:
- Demonstrate multi-wavelength network management and control in local area testbeds. ($11.3M)
- Demonstrate 40 billion bit per second cross-connect switching and 32 channel transceiver chip. ($12.1M)
- Complete analysis and report on economics of multi-wavelength network architecture and technology for local area optical networks. ($6.0M)
- Design and conduct assessments of information services needed to extend the Joint Task Force (JTF) Infrastructure from the planning phase into the execution dynamic replanning phase. ($14.0M)

(U) FY 1999 Program:
- Demonstrate full operations, multi-wavelength, experimental, system network including interoperability among testbeds distributed across several geographic domains. ($25.4M)
- Develop software applications and servers, and expand the JTF reference architecture to include execution and dynamic replanning. ($18.5M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E, Project EE-45

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	45.2	42.0	48.4	33.9
Appropriated	43.4	N/A	N/A	N/A
Current Budget	42.8	42.0	43.4	43.9

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming action ($-.6 million).
FY 1998-99 Changes reflect repricing of JTF program.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Planned	Milestones
May 96	Demonstrate network combining crypto, commercial communications, and defense secure wireless, satellite.
May 97	Demonstrate integration with advanced optical testbeds. Conduct large scale planning demonstrations.
Jul 97	Complete first phase of deployable JTF C3 development (mobile C3, plan rehearsal and refinement during deployment, intelligent interfaces).
May 98	Complete large-area demonstration of optical network and advanced network management.
Sep 98	Demonstrate initial execution and dynamic replanning functionality.
Jun 99	Demonstrate 20 gigabit per second, multi-channel, multi-media, large-area network.
Jul 99	Demonstrate advanced execution and dynamic replanning functionality.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Simulation Internet (DSI) EE-46	25,612	39,675	3,000	0	0	0	0	0	0	N/A

(U) **Mission Description**: The goal of the Defense Simulation Internet (DSI) program is to research, develop and test at scale (worldwide), a network infrastructure capable of enabling distributed, real-time, multi-media (video, voice, shared data and work spaces) simulation that will seamlessly integrate all simulation, modeling, command and control functions from early design to battle rehearsal en route to the conflict. The DSI meets DoD security requirements by using a commercial-off-the-shelf (COTS) encryption device (INES). The communications needs of the distributed, real-time, multi-media modeling and simulation community cannot be met with any other available technology. Commercial vendors are pursuing some of the required technologies, but development is too slow and unfocused to accommodate the immediacy of the Department of Defense's simulation requirements. The DSI program provides focus for the commercial development of the technologies needed by the simulation community for distributed work environments worldwide. Over 100 nodes currently extend the DSI to each of the Services, most of the Commanders-in-Chief (CINCs), some of our allies and other Government affiliated sites. These locations constitute the network's user sites; they provide valuable feedback on the technologies and methodologies being pursued and critical capability for both ongoing and major modeling and simulation events. A key mission of the DSI is to provide real-time infrastructure for the Synthetic Theater of War (STOW) 97.

(U) The DSI will transition to the Defense Information Systems Agency (DISA) Defense Information Systems Network (DISN) by the end of FY 1997 and be operated on a reimbursable basis. The transition of the DSI into the DISN provides affordability through consolidation of the costs required to operate multiple networks while continuing to support modeling and simulation requirements.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Provided network operations and user services. It is expected that the DSI will become a virtual network of DISN during the 3Q FY 1996. This will contain an estimated 30% more user sites. Operations will include the 24 hours per day/7 days per week NOC, network security, exercise/event planning and management, and the 24 hours per day/7 days per week CSC Help Desk. ($8.4M)

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- Procured telecommunication circuits: International circuits (T1 backbone), CONUS Phase II Backbone (T3) Tail Circuits (T1), upgrade select high use Synthetic Theater of War (STOW) sites to T3 tail circuit 4Q FY96. ($10.2M)
- Upgrade network: Initiated upgrade which provides ATM switches and end-to-end encryption for the wide area network interface to the sites and the edge devices which provide the local area interface with the workstation for STOW 97 (30 Sites). Upgraded to commercial standard desktop VTC. Integrate systems management to provide control of end node workstations. ($5.5M)
- Transition management: Provided programmatic integration management and engineering support through the DARPA/DISA (Advanced Information Technology Systems (AITS)) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($1.5M)

(U) FY 1997 Program:

- Provide network operations and user services. As a subnet of DISN, it is expected that by the end of FY 1997 the subnet work will contain an estimated 30% more user sites. Operations include the 24 hours per day/7 days per week NOC, network security, exercise/event planning, management and the 24 hours per day/7 days per week CSC Help Desk. Provide STOW Exercise support. ($11.6M)
- Procure telecommunication circuits: International circuits (T3 backbone), CONUS Phase II Backbone (T3) Tail Circuits (T1), upgrade high use STOW sites to high capacity tail circuits. ($13.9M)
- Upgrade network: Complete deployment of service upgrade which provides ATM switches, end-to-end encryption and the edge devices to sites which require this upgraded capability (70 Sites). Automate network management to provide real-time management of high speed high bandwidth requirements. Provide resource reservation at the application level. Complete migration of Defense Simulation Internet (DSI) network operations and maintenance to Defense Information Systems Network (DISN). ($11.7M)
- Transition management: Provide programmatic integration management and engineering support through the DARPA/DISA (Advanced Information Technology Systems (AITS)) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($2.5M)

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(U) FY 1998 Program:

- Transition management: Provide programmatic integration management and engineering support through the ARPA/DISA Advanced Information Technology Systems (AITS) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($3.0M)

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	27.5	39.7	3.0	0
Appropriated	26.5	N/A	N/A	N/A
Current Budget	25.6	39.7	3.0	0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming source ($-.3 million) and transfer of funds to the SBIR program element.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jul 96	COTS Premise Router Upgrade.
Jul 96	Add COTS Desktop VTC service.
Jul 96	Cutover to DISN LES ATM/T3 Backbone Upgrade architecture.
Sep 96	Complete Phase II Backbone Cutover (T3/ATM).
Sep 96	DISA Network operations center fully functional.
Sep 96	Fully integrate an automated network and life cycle management.

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Sep 96 Deploy ATM switches to select STOW 97 sites.
Dec 96 Deploy ATM switches to sites and end-to-end encryption (FASTLANE) to sites.
Dec 96 Initiate Service Migration to DISA.
Feb 97 Integrate applications and hardware requirements to support STOW 97.
Sep 97 Complete network services transition to DISA.

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RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Arsenal Ship/Fast Ship EE-47	0	16,382	47,618	50,000	36,000	22,000	0	0	0	N/A

(U) **Mission Description**: The objectives of this new project have far-reaching implications for the future of surface ships for the US Navy. DARPA will identify and develop high leverage technologies and acquisition improvements to support future surface ships with an emphasis on littoral missions. The project is currently structured in two parts:

1) Arsenal Ship is a high priority joint Navy/DARPA program to acquire a new capability for delivery of large quantities of ordnance (approximately 500 VLS) in support of land and littoral engagements. Key to both arsenal ship's affordability and operational flexibility is off-board integration of all but the most rudimentary C4I. The ships are to be theater assets that will operate under the authority of the joint Commanders-In-Chief (CINC's) and will receive their targeting along with command and decision information from other assets. Early in arsenal ship's life this control will be exercised through an Aegis platform, though as other assets mature, control will transition to aircraft such as AWACS or an E-2 with Cooperative Engagement Capability (CEC) capability and eventually to the Marine or Army shooter on the ground. Thus, the Arsenal Ship will not be fitted with long range surveillance or fire control sensors, but will be remotely controlled via robust data links. The data links will be secure, redundant and anti-jam in order to provide high reliability in the connectivity of the Arsenal Ships in high jamming operational scenarios. The program overall is an attempt to leverage the significant joint investment in Link 16 and CEC. The Arsenal Ship's survivability will be primarily achieved through passive design techniques. While active systems are not ruled out, they must be consistent with overall cost and manning goals. These design goals will allow the Arsenal Ship to have a very small crew (potentially, none at all) which will be a key ingredient in minimizing its life cycle costs.

This demonstration program is a non-ACAT program to design the arsenal ships and to construct and test an arsenal ship demonstrator (ASD) to evaluate this new capability while minimizing the risks in acquisition of approximately six ships (to include conversion of the arsenal ship demonstrator to a fleet operational unit.

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2) As a result of studies that DARPA has performed, it is very clear that we should expect significant re-trenching from overseas deployments by US forces. This, coupled with the growing unaffordability of maritime pre-positioned logistics, will require that future forces be deployable from CONUS. The large travel distances suggest major payoffs for achieving speeds in excess of 50 or 60 knots and, in fact speeds of 75 knots or greater show major payoffs. We will explore the potential for sealift deliveries at speeds up to 100 knots to determine the breakpoints for cost and feasibility.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:
- Select two industry teams from Phase I arsenal ship concept studies to begin Phase II development of functional baseline. ($15.0M)
- Perform initial evaluation of hydrodynamics for high speed regime. ($1.4M)

(U) FY 1998 Program:
- Complete arsenal ship Phase II functional designs by two industry teams and downselect to one team for detail design and construction of the arsenal ship demonstrator. ($47.0M)
- Assess hydrodynamic potentials for further exploitation. ($.6M)

(U) FY 1999 Program:
- Continue Phase III construction of arsenal ship demonstrator. ($50.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	16.4	65.0	40.0
Appropriated	0	N/A	0	0
Current Budget	0	16.4	47.6	50.0

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Experimental Evaluation of Major Innovative Technologies, PE 0603226E, Project EE-47

(U) **Change Summary Explanation**:

FY 1998-99 Realignment of funding profile with joint Navy/DARPA arsenal ship memorandum of agreement.

(U) **Other Program Funding Summary Cost**:

	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Navy Funding PE 64310N	3.0	25.0	141.0	70.0	80.0	11.0	0	0	0	350.0

(U) **Schedule Profile**:

Plan	Milestones
Jan 97	Award two industry teams Phase II arsenal ship contracts.
Jun 97	Complete initial 100 knot speed feasibility evaluation.
Jan 98	Award one industry team Phase III contract to start Arsenal Ship Demonstrator (ASD) detail design.
Feb 98	Assess application potential for high speed ship concepts.
Jun 00	Start test program for Arsenal Ship Demonstrator (ASD).

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Combat Hybrid Power System EE-48	4,240*	15,000	20,000	20,000	10,000	10,000	0	0	0	N/A

*The Integrated Product and Process Development Program (EE-37) is developing concurrent engineering/virtual prototyping technology that will be used in the conceptual design and analysis of the Combat Hybrid Power System.

(U) **Mission Description**: Essential requirements for U.S. Cavalry/Scout Ground Units Operations and Small Unit Operations are to acquire threat information, locate targets, communicate, reduce signatures, and be more mobile and survivable. Essential requirements for close combat units are simultaneous, sustained offensive mobility, overmatching lethality and survivability against heavy threat firepower. The platforms must be air deployable which dictates weight and volume constraints. The military is developing an array of subsystems to support these missions that include: advanced sensor suites and communication equipment, active suspension and electric propulsion systems, signature management suites, countermeasures, active defense, and electric weapons. These subsystems require either continuous or pulsed electric power and in each case a dedicated electrical power supply has been developed for each subsystem. Integration of multiple power supplies into a vehicle is not feasible due to space constraints, cost, and efficiency.

(U) The objective of this program is to address this issue by developing enabling technology and conducting demonstrations of an integrated hybrid electric power system which provides power and energy management for all of the subsystems throughout the cavalry/scout vehicle and is scaleable to future tank platforms. The hybrid electric power system will consist of an engine/alternator sized for average power demand, energy storage and power averaging components which provide both continuous and pulsed power, distribution network, subsystem control and power conditioning devices. Vehicles will be simulated to evaluate subsystem requirements, topologies, and military utility.

(U) The Reconnaissance, Surveillance, and Target Acquisition (RSTA) Vehicle Technology Program will design, develop, test, and transition to the services critical components and technology for a lightweight, highly maneuverable vehicle. The vehicle will host integrated precision geolocation, communication and RSTA sensor subsystems provided by DARPA's Small Unit Operations Program. The RSTA vehicle is the essential mobility aspect of the DARPA, U.S. Army, and Marine Corps futuristic concepts of the use of small unit operations. Critical components and technologies include a high efficiency, reduced signature hybrid electric power system; an electric propulsion system; a semi-active electromechanical suspension to double cross country speed and provide platform stabilization;

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an advanced survivability suite; and the capability to operate as either a manned or unmanned platform. The Marine Corps will develop vehicle concepts and chassis, integrate the DARPA developed components, and conduct vehicle performance tests (PE 0603640M). Additional co-funding for semi-autonomous capability will be provided by the Office of Secretary of Defense Joint Robotics Program. (PE 0603709D)

(U) Hybrid electric power is an enabling technology for future combat vehicles if electrically powered subsystems are to be implemented. The vehicles will have greatly reduced noise and thermal signatures; and improved mobility, survivability, lethality, and fuel economy. By eliminating rigid connections between components, interior layout can be optimized, significantly reducing volumetric constraints. These advantages will result in deployable, affordable combat vehicles that meet mission requirements. The programs are closely coordinated with the ".S. Army, Navy, Marine Corps, the DARPA Electric Vehicle Program (EV-01), and the DARPA Small Unit Operations Program (EE-51).

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- The Integrated Product and Process Development Program (EE-37) developed concurrent engineering/virtual prototyping technology that will be used in the conceptual design and analysis of the Combat Hybrid Power System.

(U) FY 1997 Program:

- Establish subsystem requirements, evaluate military utility, and provide modeling support to hybrid electric power system technology development. ($1.5M)
- Complete detail design of hybrid electric power system demonstration. ($1.0M)
- Complete design and conduct proof of concept experiments of engine/alternator, power averaging, power conditioning, and power distribution and controller component options. Downselect for fabrication and demonstration. ($12.5M)

(U) FY 1998 Program:

- Continue evaluation of military utility, support technology development, and transition technology to USMC and U.S. Army Advanced Technology Demonstrators. ($1.1M)
- Integrate hybrid electric power system subsystems for laboratory demonstration. ($1.2M)

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- Complete technology development and fabrication of selected full-scale engine/alternator, power averaging, power conditioning, and power distribution and control components. ($17.7M)
- Design, develop, and test critical components for RSTA vehicle hybrid electric power system, mobility subsystems, and survivability suite. ($5.0M)

(U) FY 1999 Program:

- Continue development of critical enabling technology for high risk power system components. ($8.0M)
- Complete evaluation of military utility using the future scout vehicle virtual prototype, support technology development, and transition technology to USMC and U.S. Army Advanced Technology Demonstrators. ($1.0M)
- Test and evaluate hybrid electric power system in a laboratory demonstration. ($11.0M)
- Fabricate and demonstrate critical RSTA vehicle subsystems including: power system, propulsion, suspension, survivability, and controls. ($8.5M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	15.0	20.0	20.0
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0	15.0	25.0	28.5

(U) **Change Summary Explanation**:

FY 1998-99 Reflects repricing of requirements.

(U) **Other Program Funding Summary Cost**:

	FY 1996	FY 1997	FY 1998	FY 1999
PE 0603640M	1.5	2.0	2.5	3.0
PE 0603709D	N/A	N/A	2.0	2.0

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(U) **Schedule Profile:**

Plan	Milestones
Aug 97	Establish subsystem requirements, evaluate military utility, and support hybrid electric power system technology development using integrated, hybrid electric powered combat vehicle virtual prototypes.
Jan 98	Downselect components for final combat hybrid power system demonstration.
Jun 98	Complete combat hybrid power system integration and test plan.
Sep 98	Test RSTA vehicle critical components and conduct critical design review.
Sep 99	Demonstrate RSTA vehicle subsystems.
Dec 99	Demonstrate power system for future scout vehicle and establish military utility for technology transition to the Services.
Sep 00	Assemble subsystems and integrate into Marine Corps RSTA vehicle chassis.
Mar 01	Demonstrate 5-ton RSTA vehicle system capabilities.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tier III Minus UAV EE-49	23,201	14,749	5,000	0	0	0	0	0	0	N/A

(U) **Mission Description**: The objective of this program is to develop and demonstrate a Low Observable High Altitude Endurance Unmanned Air Vehicle (LO HAE UAV) system, including a ground segment, capable of providing the war fighter with the near real time ability to assess battlefield situations. This system will provide continuous, all weather, day/night, wide area reconnaissance and surveillance in direct support of the Joint Forces Commander. It will consist of aircraft, sensors, communications and interfaces to theater systems in support of tactical warfighters at various levels of command. The LO HAE UAV will provide wide area search (over 15,000 sq nm per mission) with either an Electro-Optical (EO) or Synthetic Aperture Radar (SAR) system at 1m resolution. In addition, it will provide 600 spot images per mission with either sensor at 0.3m resolution. The search and spot modes can be interleaved with attendant reductions in the overall coverage. The system will support a targeting accuracy of at least 20m CEP.

(U) The low observables capabilities of the system will allow it to operate in high threat environments where manned reconnaissance or other operational assets are not viable options.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:
- Complete system integration and initiate Phase II flight test. ($11.2M)
- Prepare Air Vehicle #2 for Flight Test. ($12.0M)

(U) FY 1997 Program:
- Complete System Integration and Flight Test of Air Vehicle #2. ($14.7M)

(U) FY 1998 Program:
- Prepare and Flight Test Air Vehicle #3. ($5.0M)

(U) FY 1999 Program: N/A

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Experimental Evaluation of Major Innovative Technologies, PE 0603226E, Project EE-49

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	24.7	14.7	5.0	0.0
Appropriated	23.7	N/A	N/A	N/A
Current Budget	23.2	14.7	5.0	0.0

(U) **Change Summary Explanation**:

FY 1996 Reflects minor repricing.

(U) **Other Program Funding Summary Cost**:

	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	Cost to Complete	Total Cost
Related RDT&E	56.3	66.0	41.0	18.0	23.0	0	0	0	N/A

PE 0305154D Defense Airborne Reconnaissance Program

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Commence fabrication of vehicles #3 and #4.
Jun 96	Prepare Air Vehicle #2 for Flight Test.
Dec 96	Begin Taxi and Flight Test Air Vehicle #2.
Jun 97	Complete Air Vehicle #3.
Aug 97	Conduct Limited Technical User Demonstrations.
Nov 97	Survivability Testing.

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R-1 ITEM NOMENCLATURE
Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Sensor and Exploitation Systems EE-50	*	69,201	85,854	92,755	109,400	116,787	135,287	135,287	Continuing	Continuing

* Programs included in this project were previously funded under Project EE-40.

(U) **Mission Description**: This project represents a refocusing and transition of pertinent elements of the Critical Mobile Targets (WAR BREAKER) project (EE-40) into a concentrated effort to empower the battle commander with comprehensive battlespace awareness. The development efforts described herein embody key sensor demonstrations and the exploitation of sensor products. These efforts, in conjunction with those described in Project EE-53 (Information Integration Systems), seek to develop the systems needed to provide the warrior with situational awareness and battlefield dominance. The strategic goal of this project is to utilize diverse, complete, sensing of the battlefield environment, including sensors which can counter Camouflage, Concealment and Deception (CC&D), and provide near-real-time, semi-automatic, exploitation of wide-area moderate (and high) resolution imagery and provide semi-automated recognition and birth-to-death tracking of high value units and critical moving targets. These goals are being addressed by the Counter CC&D Advanced Concept Technology Demonstration (ACTD), the Semi Automated Imagery Intelligence (IMINT)Processing (SAIP), Moving and Stationary Target Acquisition and Recognition (MSTAR), Moving Target Exploitation (MTE), and Automatic Target Recognition (ATR) applications programs.

(U) The goal of the Counter CC&D ACTD is to provide significant enhancement of the military's capability to detect obscured targets hidden under natural and artificial camouflage. Specific goals include validation of Foliage Penetration (FOPEN) target detection capability (0.1 FA/sq.km max) with data from the P-3 Ultra-Wideband UHF Synthetic Aperture Radar (SAR) testbed and the DARPA-sponsored Swedish Carabas I Very High Frequency (VHF) SAR tests; and demonstrations of real-time processing of FOPEN high resolution SAR image formation, Radio-Frequency Interference (RFI) suppression and Automatic Target Detection/Classification (ATD/C) algorithms. An airborne demonstration sensor will be developed for demonstration on a manned platform providing inputs via narrowhead tactical data links to the image exploitation capabilities in SAIP. The target queuing techniques developed under MSTAR will be extended to include unique characteristics of VHF/UHF band, and polarization to improve the reliability of detection and discrimination of tactical targets. The program will ultimately combine FOPEN technology with other sensor technologies (e.g., hyperspectral sensors) on an Endurance UAV (unmanned aerial vehicle), and develop combined exploitation technologies for insertion into the Common Imagery Ground/Surface System (CIGSS).

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(U) The Semi-Automated IMINT Processing (SAIP) will develop, test and transition to the operational user, automated algorithms and semi-automated tools that enhance the warfighter's capability to: process SAR, then EO/IR, and eventually multispectral imagery; conduct wide-area search for Ground Order of Battle and Missile Order of Battle targets; perform rapid site-monitoring and site modeling; and produce target reports in near real-time (< five minutes). SAIP will consist of baseline, enhanced, and transition systems. Goals for the baseline system are: automatic target cueing and classification for a limited set of vehicles; object level change detection; force recognition to the company level; and interactive target recognition and terrain delimitation. Goals for the enhanced system are: site modeling and monitoring with EO; addition of SIGINT cueing; and rapid target insertion. Goals for the transition system are to add enhanced automatic target recognition (30 targets); flexible force recognition to the regiment level; site modeling and monitoring with SAR data; rapid target insertion and, on-the-fly training. SAIP will integrate program products that are being refocused and transitioned from the WAR BREAKER Program.

(U) The goal of the Moving and Stationary Target Acquisition and Recognition (MSTAR) program is to achieve a major advance in SAR Automatic Target Recognition (ATR) performance through fundamental and innovative technology developments. Other program goals include: significant advances in interactive image exploitation environments and performance; the development of rapid target model construction and rapid ATR updating methods; the development of resource management systems for surveillance and exploitation, and the development and demonstration of ATR-based and single/multiple-scale SAR image formation-based methods for reducing HAE UAV data rates to SATCOM-supportable bandwidths, and the conduct of basic university research into ATR.

(U) The Moving Target Exploitation (MTE) combines high resolution Moving Target Indication (MTI) radar returns with moving target Synthetic Aperture Radar (SAR) imaging to achieve target detection, screening, identification, and birth-to-death tracking within the timelines required for countering time critical targets. Three techniques are being investigated: discriminate desired targets using high range resolution profiling; image moving targets via enhanced Inverse SAR image information; and classify moving targets using image shape and motion characteristics. Specific applications are targeted for the Joint Surveillance Targeting Attack Radar System (JSTARS), the U-2, and the Dark Star and Global Hawk High Altitude Endurance Unmanned Aerial Vehicles.

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(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- See Project EE-40 for FY 1996 Program accomplishments.

(U) FY 1997 Program:

- Complete Foliage Penetration (FOPEN) concept design and the integration of all system design components for a FOPEN Demonstrator radar targeted for a medium or high altitude endurance Unmanned Aerial Vehicle. Complete critical technology demonstration of ultrawideband antenna design, airborne real-time processing interface, radio-frequency interference suppression, and FOPEN automatic target detection/classification. Develop a test and evaluation plan with measurement criteria, validation approach and risk assessment matrix by critical technologies to begin the Counter CC&D ACTD. ($10.0M)
- Transition of all component projects into the SAIP ACTD will be completed and integration continued to achieve enhanced system objectives in continued collaboration with the Defense Airborne Reconnaissance Office (DARO). The site modeling and monitoring component will be integrated, additional Missile Order of Battle and Ground Order of Battle models and algorithms inserted, and the system ported to a High Performance Computer architecture. Tests will be done on system performance with Tier III- and national imagery and the enhanced SAIP system will be available to the Battlefield Awareness and Data Dissemination ACTD (EE-53) to serve as its imagery processor. A test at an overseas operational unit will be initiated. ($35.0M)
- The MSTAR 10 target recognition system with limited extended operating condition (EOC) capability will beintegrated and evaluated, then matured into a 15 target system with increased EOC capability. Concepts and prototypes for interactive exploitation, rapid target insertion and rapid ATR updating will be developed and evaluated. A single scale ATR-based bandwidth compression will be completed and demonstrated in the SAIP exploitation van, and an initial multi-scale compression architecture will be developed and demonstrated in the lab, University research in basic automatic target recognition will continue, with techniques transferring to technology integration programs. ($19.7M)
- The Moving Target Exploitation (MTE) program will demonstrate high resolution MTI, moving target imaging, and ATR in a virtual JSTARS testbed. Perform JSTARS data collection to support concept validation. Develop U-2 integration and virtual testbed. ($4.5M)

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(U) FY 1998 Program:

- Integration will continue to achieve Semi-Automated IMINT Processing (SAIP) transition system objectives. Tests with Global Hawk imagery will be conducted. Transition to the operational customer, U.S. Atlantic Command, will begin. ($30.4M)
- Develop Airborne Demonstrator radar for test and evaluation for demonstration on a manned platform providing inputs via narrowband tactical data links to the image exploitation capabilities in SAIP. The ATD/C techniques developed under Air Force RADCON program and MSTAR will be extended to include unique characteristics of VHF/UHF band, and full polarization to improve the reliability of detection and discrimination of tactical targets. ($25.0M)
- The MSTAR 15 target recognition system with increased EOC capability will be integrated and evaluated, then matured into a 20 target system with greater EOC capability. The system then will be fully characterized vs. the defined target set and full EOC dimensions. Full prototypes for interactive exploitation for two analyst missions will be developed and evaluated. A rapid target insertion prototype system will be built and evaluated, creating 5 target models and rapid ATR training systems as a baseline. A resource management prototype will be built and evaluated. Development, integration and demonstrations will continue on a single scale compression and multiple scale bandwidth compression. Airborne and field demonstrations are planned. ($19.7M)
- Conduct U-2 data collection and perform an operational demonstration of Moving Target Exploitation on JSTARS. ($10.7M)

(U) FY 1999 Program:

- The evaluation of the MSTAR 20 target/full EOC system will be completed, system technology will be transferred to the SAIP and STARLOS programs, and a two year effort to develop a high performance computing adaptation for an MSTAR real time demonstration system will begin. Development and evaluation of resource management, rapid target insertion, rapid ATR updating and interactive exploitation systems will continue, with key milestones occurring in FY 2000. ($28.0M)
- Conduct U-2 and HAE operational demonstrations. ($9.0M)
- Complete transition of the SAIP system to OCONUS for military operations. ($20.5M)

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- Counter CC&D ACTD will complete Airborne Demonstrator Flight Test and Evaluation on manned platform in conjunction with SAIP ground exploitation capabilities during tactically significant military exercises to verify performance capabilities of ATD/C of tactical targets in CC&D. Initiate integration of FOPEN and Hyperspectral sensors into a Medium or High altitude/endurance (HAE) UAV depending on suitability of sensor and UAV CONOPS. ($35.5M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	69.2	93.5	82.8
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0	69.2	85.9	92.8

(U) **Change Summary Explanation**:

FY 1998-99 Reflects minor repricing and program rephasing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Oct 96	MSTAR 10 target recognition system demo with initial EOCs; downselect of MSTAR developers to enter Phase 2.
Nov 96	Demonstrate and test baseline SAIP system with ASARS-II at Edwards AFB.
Nov 96	Demonstrate single-scale capability of data compression and screening in SAIP system.
Dec 96	Ground demonstration of real time FOPEN ATD/C processor.
Apr 97	JSTARS data collection and system demonstration (MTE).
May 97	FOPEN Airborne Demonstrator Requirements Decision.
Jun 97	Demonstrate required MTE performance in JSTARS virtual testbed.
Jun 97	Test SAIP with national product.

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Aug 97	Demonstrate multi-scale capability of data compression in lab environment.
Aug 97	Demonstration of VHF/UHF Antenna technology for FOPEN Demonstration Radar.
Nov 97	Second major demonstration of MSTAR ATRs: 15 targets with increased EOCs.
Jan 98	Airborne demo of data compression/screening capability on U-2R.
Jun 98	Operational demo of MTE system on JSTARS.
Jul 98	Initiate SAIP transition to USACOM.
Aug 98	Demonstrate required MTE performance in U-2 virtual testbed.
Nov 98	Start Integration of FOPEN Airborne Demonstration Radar.
Nov 98	Final MSTAR ATR demo: 20 targets, full range of EOCs; transition to SAIP.
Feb 99	Operational demonstration of MTE with the U-2.
Apr 99	Operational demonstration of MTE with an HAE.
Jun 99	Flight demonstration of FOPEN Radar with CIGSS Image Exploitation System.
Sep 99	Complete SAIP transition.
Sep 99	HAE demonstration (MTE).

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RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Small Unit Operations EE-51	18,486	52,666	51,580	39,897	72,913	70,000	70,000	40,000	Continuing	Continuing

* Related FY 1996 effort performed in projects ST-11 ($3.5M) and TT-04 ($13.1M).

(U) **Mission Description**: The United States will continue to commit military forces abroad as an essential instrument of foreign policy. With declining resources and a smaller military, the Services must be prepared to quickly project sufficient power to achieve United States objectives more rapidly and effectively than we are currently able. The deployment of our forces will be restricted by lift assets and in-theater infrastructure; and they will operate under more complex rules of engagement. Adversaries who are not very powerful may possess sophisticated technology that will place our forces at risk. These risks are increased if our forces are massed to conduct traditional conventional operations. To fight effectively in the future, the Army and Marine Corps are developing concepts of operation (Army - Force XXI and Marine Corps - Sea Dragon) whose tactical implementation will vary, but with similarities that include lighter, more lethal, more flexible forces that are widely dispersed through out the battlefield. The objective is to enable more capable dispersed units to effectively perform warfighting operations traditionally accomplished with larger massed forces. These forces must be able to quickly control a large battlespace with fewer forces, control the operational tempo, engage enemy targets with remote fire, and operate effectively across the spectrum of conflict and in a variety of environments.

(U) The keys to success for these units are a vastly improved and highly integrated comprehensive awareness system, robust communications, and an integrated, scaleable common grid of the battlespace. While there are many technology developments underway that will assist the Services to accomplish their objectives, at the tactical level there are technology gaps that DARPA will help narrow under the Small Unit Operations program. Technology development efforts will focus on a comprehensive awareness capability that provides real-time, essential information for small units and individual warfighters; wireless communication technologies to permit exchange of voice, digital and video data with other systems; geolocation technologies that provide navigation information in built-up, forested and mountain environments; internetted tactical surveillance and targeting sensors to complement information requirements not satisfied by national, theater, and component sensor programs; and automated tasking and control technologies for air and ground systems. As these technologies mature they will be tested and evaluated. Engineering demonstrations with

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combatant participation will be conducted to assess program progress in a realistic environment which provides critical user feedback. After successful tests and evaluation, or further refinement of the technologies, they will be integrated and tested with operational units.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Developed upper level system architecture, conducted engineering analysis and evaluated advanced concepts/technologies for SUO applications. ($2.8M)
- Completed communications, data stripping and information understanding analyses in support of comprehensive tactical awareness enhancements. Developed candidate communications network architectures. ($1.5M)
- Upgraded and field demonstrated Sea Dragon Communications and Coordination (SDC2) in preparation for Sea Dragon/Force XXI Exercise in 1997. ($7.0M)
- Initiated development of requisite technologies, including precision clocks, to provide precision geolocation for dismounted combatants in a variety of environments, including wooded, mountainous, urban and within buildings. ($4.4M)
- Developed acoustic array sensors, initiate internetted sensor processing studies. ($2.8M)

(U) FY 1997 Program:

- Assess advanced concepts and technologies for SUO applications. ($1.0M)
- Conduct system integration and demonstrate SUO technologies at CINC and Warfighter exercises. ($5.0M)
- Complete concept of operations, requirements, and architecture definition for below-brigade soldier situation awareness and tasking system. ($1.0M)
- Initiate technology developments for the comprehensive situation awareness and tasking system, focusing on tactical picture generation, tactical forecast, situation assessment functionality. ($5.4M)
- Continue to develop enabling technology for reactive planning and support asset tasking and control. ($7.2M)
- Initiate technology development for tactical communications capability. ($7.4M)
- Complete SDC2 and participate in Joint Army and Marine Corps Exercise. ($2.4M)
- Continue development of requisite technologies to provide precision geolocation. ($6.9M)
- Apply and integrate sensing/surveillance technology into tactical sensing developments. ($7.3M)
- Integrate multiple sensors and processing capabilities. ($8.2M)

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- Initiate mobility and remote targeting concepts. ($.9M)

(U) FY 1998 Program:
- Assess advanced concepts and technologies for SUO applications. ($1.0M)
- Conduct system integration and demonstrate SUO technologies at CINC and Warfighter exercises. ($5.2M)
- Continue technology developments for the comprehensive awareness and tasking system focusing on plan generation and support asset tasking functionality. ($7.2M)
- Continue to develop enabling technology for reactive planning and support asset tasking and control. ($7.5M)
- Continue technology development for tactical communications capability. ($7.5M)
- Continue development and evaluation of requisite technologies to provide precision geolocation. ($8.3M)
- Apply and integrate sensing/surveillance technology into tactical sensing developments. ($4.3M)
- Integrate multiple sensors and processing capabilities. ($10.5M)
- Initiate remote targeting/remote firing capability and mobility technologies. ($1.1M)

(U) FY 1999 Program:
- Assess advanced concepts and technologies for SUO applications. ($.9M)
- Conduct system integration and demonstrate SUO technologies at CINC and Warfighter exercises. ($5.3M)
- Continue technology developments for the comprehensive awareness and tasking system focusing on plan generation and support asset tasking functionality. ($14.9M)
- Continue to develop enabling technology for reactive planning and support asset tasking and control. ($4.8M)
- Continue technology development for tactical communications capability. ($9.6M)
- Continue development and evaluation of requisite technologies to provide precision geolocation. ($9.6M)
- Apply and integrate sensing/surveillance technology into tactical sensing developments. ($6.6M)
- Integrate and demonstrate multiple sensors and processing capabilities. ($13.2M)
- Develop and integrate remote targeting/remote firing capability. ($2.0M)
- Mature and demonstrate SUO mobility concepts for sensors, resupply and sustainment. ($3.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E, Project EE-51

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	52.7	51.6	39.9
Appropriated	0	N/A	N/A	N/A
Current Budget	18.5	52.7	52.6	69.9

(U) **Change Summary Explanation**:

FY 1996-03 Funding transferred from Command & Control Information Systems Project EE-21, Advanced Ship/Sensor Systems Project EE-36, Unmanned Undersea Vehicle Systems Project EE-39, Critical Mobile Targets Systems Project EE-40, Sensors and Exploitation System Project EE-50, Intelligent Systems and Software Project ST-11, and Advanced Land Systems Project TT-04.

FY 1998 Minor program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Aug 96	Complete initial requirements definition for Brigade/Battalion and Combatant Warfighter's Tactical Associate.
Mar 97	Complete performance testing of multiple precision clock units in hybrid packages.
Mar 97	Demonstrate sniper, mortar, mine and thru-wall detection sensors at Force XXI EXFOR AWE. Demonstrate near-term mobility and self-location technology at Force XXI EXFOR AWE. Complete Sea Dragon Communications and Coordination (SDC2) program and participate in Sea Dragon/Force XXI exercise.
Jul 97	Support Military Operations in Urban Terrain (MOUT) Advanced Concept Technology Demonstration (ACTD) with SUO technology.
Jul 98	Downselect final communications architecture.
Dec 97	Demonstrate feasibility of local tactical picture generation module.
Dec 97	Demonstrate and characterize various breadboard precision geolocation technologies in restricted environments.

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Mar 98	Complete precision clock environmental and cell life testing.
Sep 98	Demonstrate initial integration of reflective and reactive planning.
Dec 98	Demonstrate and characterize various brassboard geolocation technologies.
Sep 99	Demonstrate reflective and reactive planning and tasking modules.

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Experimental Evaluation of Major Innovative Technologies, PE 0603226E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Integration Systems EE-53	*	67,914	98,400	105,300	105,000	121,000	118,800	110,000	Continuing	Continuing

*Programs included in this project were previously funded under Project EE-21 and EE-40.

(U) **Mission Description:** This project represents a refocussing and transition of pertinent elements of the Critical Mobile Targets (WAR BREAKER) project (EE-40) and Command and Control Information Systems Project (EE-21) into a concentrated effort to empower the battle commander with comprehensive battlespace awareness. The goal of this project is to take diverse inputs, including those planned as outputs from the Sensors and Exploitation Project (EE-50), and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield data-base and knowledge-base, and through the use of wideband dissemination and integrated sensor management allow multi-site, real-time, collaborative situation assessment and course-of-action evaluations. These goals are being addressed by the Dynamic Multi-User Information Fusion (DMIF) project, the Battlefield Awareness and Data Dissemination (BADD) ACTD and the Airborne Communications Node (ACN) project.

(U) Dynamic Multi-User Information Fusion (DMIF) seeks to develop and evaluate a prototype operational system that amalgamates diverse sensor observations and rectifies disparate fusion products to provide the warfighter with consistent and robust battlefield awareness. The system will maintain birth-to-death tracking of high value targets; use distributed, collaborative, dynamic, and all-source correlation, fusion and situation assessment; exploit terrain limitations, enemy doctrine, and first-principle constraints on military operations to construct a hierarchical representation of all battlefield activity; and define a reference architecture to ensure software reuse and in-field modifiability, full uncertainty accounting, and Global Command and Control System (GCCS) Leading Edge Services (LES) compliance.

(U) The objective of the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) is to deliver a synchronized, consistent description of the battlespace, allowing the field commander to design or adapt his command and control system to mission needs for effective application of force. The description of the battlespace provided to the warfighters under this ACTD will be tailored to their mission needs by intelligent selection of information to be broadcast and intelligent request (pull) and filtering at the warfighter workstation so that needed information is available. The ACTD focuses on the dissemination of the data required to present a consistent description of the battlespace and will provide the required infrastructure,

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information management capabilities, user applications and interfaces to intelligently manipulate data products, apply commercial direct broadcast technology for wide-band, low-cost dissemination of multi-media information and provide tactical internet services for two-way communications. A toolset of Global Command and Control System compliant applications will be provided by the ACTD to support the warfighter in the extraction of information about threats and other important aspects of the battlefield from nearby and remote real-time sensor data streams, intelligence sources and stored data bases. BADD will be evaluated through participation in exercises-and demonstrations, and through insertion into ongoing pilot services, such as the Joint Broadcast Service installed in the European Theater in April 1996.

(U) The Airborne Communications Node (ACN) program, a communications payload for the Global Hawk High Altitude Endurance Unmanned Aerial Vehicle will be developed that will provide robust gateway, bridging, routing and multimedia communication services for Joint Task Force (JTF) early entry forces and mobile warfighters deployed beyond fixed tactical communication infrastructures. ACN will support information transport requirements, providing situation awareness, planning and rehearsal and JTF coordination. The ACN will utilize an open systems architecture and high speed fiber-optic data network that will be software reconfigurable, allowing the JTF commander to maximum flexibility to tailor the payload to the particular communications requirements of each situation.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- See Projects EE-40 and EE-21 for FY 1996 Program accomplishments.

(U) FY 1997 Program:

- In the DMIF program, continue development of reusable terrain generation, agile modeling and text processing modules, and demonstrate a prototype stand alone, multi-source, inference-based fusion system for a limited target set at Roving Sands 97. Initiate the construction of a simulated test environment for early assessments of user requirements and operational concepts, for performance evaluations and validation of fusion engines, and for architecture integration. Initiate the development of product finishers to tailor battlespace awareness to the specific needs of operation users including precision strike and collection management. ($23.2M)
- Battlefield Awareness and Data Dissemination (BADD) ACTD: Participate and be evaluated in Task Force XXI Army Warfighting Experiment. Demonstrate system capabilities in a joint demonstration (called the Joint Air

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Component Demonstration) involving Navy, Marine and Air Force elements. Capabilities and services to be evaluated include: Information Dissemination Manager node located in Washington, DC; Warfighter's Associate terminals in use by the Army and Marines at Fort Irvin, at 29 Palms by the Marines, and at Camp Pendleton/NRaD by the Navy and Marines; leased GBS commercial satellite communications interfaces; creation and dissemination of an operational picture of red and blue force status; and dissemination of integrated imagery, video, signals intelligence, terrain, weather, Global Command and Control System (GCCS) and Maneuver Control System (MCS) data. ($34.1M)

- Conduct technology development to achieve full-up to achieve full-up Airborne Communications Node (ACN) payload, including EMI mitigation/optimized antenna design and placement, communications controller and handheld receiver/transmitter and antenna development. Initiate ACN payload design. ($10.6M)

(U) FY 1998 Program:

- Complete technology developments to achieve full-up ACN payload. Complete payload development, subsystem integration and test. Begin demonstrations in a system integration laboratory environment. ($19.0M)
- BADD ACTD: Participate and be evaluated in an OCONUS exercise increasing the level of automation previously provided to overseas users and extending, in that theater, information management and dissemination support at the level of individual Battalions/ships. Provide new information management capabilities to include creation of a 3D graphical depiction of a consistent operational picture by near-real-time integration of all relevant data bases, identification and semi-automated resolution of differences. ($49.0M)
- Continue the development of the DMIF system to include birth-to-death tracking of all battlefield objects and the capability to rectify multiple collaborative and distributed fusion products. Initiate the development of fusion engines, standards, and architecture designs needed to create a product line of flexible, open, and distributed battlespace awareness systems. Conduct a MAJCOM demostration of the DMIF II capability. ($30.4M)

(U) FY 1999 Program:

- Complete demonstrations in system integration laboratory environment. Initiate ACN integration into global Hawk HAE UAV. Begin ACN field demonstrations. ($20.0M)
- BADD ACTD: Continue frequent participation in operational exercises to validate the incremental additional of operational capabilities Examples of increased information management functionality include the creation of the consistent operational picture by near-real-time integration of all relevant data bases, and identification and automated resolution of differences. Provide capabilities to preform resource management

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of multiple communication paths. Evaluate this capability via participation in a joint demonstration using the Airborne Communications Node (ACN). ($44.9M)

- Extend DMIF architecture to create a product line of fusion systems that work flexibly and seamlessly with existing battlefield information systems. Incorporate DMID products into emerging systems such as BADD and GCCS LES. Complete testing and validation of fusion engines and architecture and transition the system to users. ($40.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	67.9	90.4	100.3
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0	67.9	98.4	105.3

(U) **Change Summary Explanation**:

FY 1998 Increase reflects restructuring of funds to realize the development of key new components for the Dynamic Multi-User Information Fusion (DMIF) Program.

FY 1999 Increase reflects addition to the Airborne Communications Node (ACN) Program to enable manned aircraft demonstration and begin procurement of Phase III Global Hawk.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Nov 96	Demonstrate BADD capability (joint exercise) - Joint Air Component Demonstration.
Feb 97	Support Task Force XXI Advanced Warfighting Experiment.
Apr 97	Complete definition of ACN antenna design and placement.
Apr 97	Demonstrate Dynamic Multi-User Information Fusion (DMIF) capability at JPOC 97.
Apr 97	Demonstrate BADD capability (Roving Sands '97).

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Jul 97	Deliver DMIF-I to a MAJCOM.
Sep 97	Complete DMIF testbed for system design, concept of operations and human computer interface development.
Oct 97	Demonstrate BADD capability (JWID '97)
Jun 98	Complete integration and lab demo of DMIF II.
Jul 98	Complete ACN payload design, development, subsystem integration and test.
Jul 98	Support operational exercise OCONUS and CONUS upgrade.
Sep 98	Field demo of DMIF II stand alone system.
Sep 98	Deliver BADD pilot service to OCONUS.
Oct 98	Demonstrate BADD capability (JWID '98).
Jan 99	Complete demonstration of ACN in systems integration laboratory environment.
Sep.99	Complete ACN payload integration into Global Hawk HAEUAV and conduct test.
Oct 99	Demonstrate BADD capability (JWID '99).
Jun 99	Transition DMIF-II capability.
Sep 00	Complete BADD transition to DISA, GBS Joint Program Office (JPO) and the Services.
Sep 00	Transition to DISA, ACOM and GBS PO, final operational service.
Oct 00	Demonstrate BADD capability (JWID '99).

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Submarine Technology, PE 0603569E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Subtech AS-01	31,455	0	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** The objectives of this project are to develop and demonstrate advanced concepts and to pursue critical enabling technologies for future ship classes. The evolving worldwide threat of quiet diesel submarines and the proliferation of sophisticated submarine and weapons capabilities available to third world countries necessitates that the U.S. continue to maintain a superior submarine force. U.S. submarine technologies must keep pace with changing threats and remain immune to technological surprises, but declining resource availability mandates that this be done affordably. Therefore, the main thrust of this project is to provide far-term solutions for both increasing ship affordability and enhancing our operating capabilities in the littorals.

(U) This project continues to develop and demonstrate innovative technologies aimed at enhancing the submarine's stealth, and countering the adversary's stealth, including hydrodynamic control, advanced materials/structures, acoustic and non-acoustic stealth and efforts for signature management. These technologies will significantly enhance submarine stealth and survivability. They form the basis for efforts addressing affordability through improvements in structural acoustic design capabilities, innovative machinery mounting systems and high reliability propulsion systems.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Demonstrated Active Structural Control (ASC) shock attenuation techniques on full-scale platform. Demonstrated an acoustic sound cancellation system for stealth applications. ($1.4M)
- Conducted initial design, prototype development, and test of active transmission vibration isolation mount components. ($1.3M)
- Constructed lightweight truss structure at 1/4-scale. Evaluate techniques for vibration reduction at land-based test facility. ($2.3M)
- Conducted a demonstration of drag reduction and maneuvering control using Electromagnetic Turbulence Control (EMTC) on a Mk48 torpedo in the Langley Tow Tank Facility. ($2.9M)
- Conducted supercavitation projectile technology proof-of-principle tests. ($1.0M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Submarine Technology, PE 0603569E, Project AS-01

- Continued transition of magnetic levitation technology to the United States. Conduct benchmark tests with 1/4-scale lightweight truss structure mounted in submarine hull and evaluate structural acoustics benefits for the integrated concept. ($6.9M)
- Continued programs to enhance multi-mission capabilities and operational effectiveness for submarine operations in littoral regions including development and demonstration of both signature reduction and management concepts, and improved situational awareness. ($12.8M)
- Conducted initial design of an active rotor activation and control system. ($2.9M)

(U) FY 1997 Program: N/A

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	7.5	0	0	0
Appropriated	30.2	N/A	N/A	N/A
Current Budget	31.5	0	0	0

(U) **Change Summary Explanation**:

FY 1996 Increase is a net of inflation savings ($-.5 million), supercavitation test requirements ($+1.0 million), and minor repricing ($+.8 million).

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 96	Demonstrate proof-of-concept system for assessing submarine vulnerability to detection when operating in littoral regions.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Submarine Technology, PE 0603569E, Project AS-01

May 96	Full-scale demonstration of active shock attenuation system.
Jun 96	Demonstration of Electromagnetic Turbulence Control (EMTC) in a high speed water tunnel on a Mk48 torpedo for drag reduction and control authority.
Jun 96	Testing of integrated 1/4-scale lightweight truss structures with magnetic levitation technologies in submerged model.
Jul 96	Concept feasibility demonstration of active noise cancellation system.
Aug 96	Full-scale demonstration of active control of turbine blade resonance vibration.
Aug 96	Demonstrations of selected mission enhancements and signature reduction/management technologies in submarine design concepts.
Sep 96	Complete supercavitation projectile proof-of-principle test.
May 97	Demonstrate submarine signature management system assessing detection vulnerability (acoustic and nonacoustic threats), recommending means to reduce signature, and route planning in a dynamic threat environment.
May 97	Demonstrate 1/4-scale innovative submarine sail.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Defense Reinvestment, PE 0603570E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Reinvestment	181,623	0	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** The purpose of the Technology Reinvestment Program (TRP) is to enhance the technological superiority and affordability of U.S. military technology through dual-use projects designed to directly improve military capabilities while also having potential pay-offs in the commercial sector. Key to meeting the program objectives is the selection of particular technology areas which can serve both a military and a commercial market, thereby encouraging a partnership and cost sharing between commercial industry and the Department of Defense.

(U) The initial competition held in FY 1993/1994 resulted in the selection of 212 proposed partnerships. Lessons learned from this competition were shared with potential future partners through nationwide multi-city outreach seminars. These lessons are analyzed and applied, as appropriate, to enhance the program each year.

(U) Based on lessons learned, a second more focused competition was conducted in late FY 1994 that resulted in an additional 39 partnership agreements.

(U) The FY 1995 program solicited proposals in a general competition with emphasis on developing dual-use technologies. Due to the FY 1995 congressional rescission, only Technology Development was competed. Changes in authorization language were implemented to provide additional assistance for small businesses and increased, formal participation by the military services.

(U) The FY 1996 program continued only projects initiated in prior years.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Funded only options and due bills associated with projects initiated in prior years.

(U) FY 1997 Program: N/A

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Defense Reinvestment, PE 0603570E

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	500.0	-	-	-
Appropriated	190.0	N/A	N/A	N/A
Current Budget	181.6	-	-	-

(U) **Change Summary Explanation**:

FY 1996 The reductions in FY 1996 reflect inflation savings ($4.7 million) reprogrammed as part of above threshold reprogramming actions; rescissions imposed as part of the FY 1996 supplemental ($.4 million); and an assessment to finance the statutorily mandated SBIR program ($3.3 million).

FY 1997 Program completed in FY 1996.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
1st Qtr FY 95	Signed agreements with partners selected under focused competition.
3rd Qtr FY 95	Selected and established new partnerships identified during the general competition announced in late FY 1994.

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DATE: May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST (In Thousands)	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Electronics Technologies	**419,863**	**332,100**	**328,676**	**322,785**	**337,992**	**325,512**	**320,140**	**322,779**	**Continuing**	**Continuing**
IR Focal Plane Array (IRFPA) MT-03	39,493	23,995	9,000	14,000	0	0	0	0	0	N/A
Electronic Module Technology MT-04	96,674	66,149	73,206	97,590	150,760	188,012	195,140	199,525	Continuing	Continuing
Tactical Information Systems MT-05	20,912	19,076	34,884	35,646	31,000	27,500	27,500	27,500	Continuing	Continuing
Microwave and Analog Front End Technology (MAFET) MT-06	39,858	47,921	48,071	39,000	25,000	0	0	0	0	N/A
Centers of Excellence MT-07	16,884	14,000	0	0	0	0	0	0	0	N/A
Manufacturing Technology Applications MT-08	59,507	34,051	33,455	25,000	21,951	10,000	10,000	10,000	Continuing	Continuing
Advanced Lithography MT-10	46,109	51,404	40,000	40,000	40,000	40,000	37,500	35,754	Continuing	Continuing

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RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Computer-aided Acquisition and Logistics Support MT-11	31,073	20,704	15,000	0	0	0	0	0	0	N/A
Microelectromechanical Systems (MEMS) MT-12	29,514	54,800	75,060	71,549	69,281	60,000	50,000	50,000	Continuing	Continuing

(U) **Mission Description**: The Advanced Electronics Technology program element is budgeted in the Advanced Development Budget Activity because it seeks to design and demonstrate state-of-the-art manufacturing and process technologies for the production of various electronics and microelectronic devices, sensor systems, actuators, gear drives that have both commercial and military applications. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements and enhance the U.S. industrial base.

(U) The IR Focal Plane Array project focuses on the establishment of a manufacturing capability for advanced infrared sensor arrays for major weapons systems. This industrial base will allow the systems to meet specification requirements at approximately 1% of the current cost.

(U) The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog, and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards and emerging technologies such as high density Multichip Modules (MCMs).

(U) This project contains three major programs: Head Mounted Displays (HMD), Smart Modules, and Warfighter Visualization. The Head Mounted Display program is developing world-class miniature displays and integrating these displays into head and helmet mounted configurations for use by pilots, combat vehicle crews and individual warriors as well as for virtual environments and simulation. Smart Modules is a program to design and develop prototype

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modules, using core technologies that sense, think, and communicate, and integrate them into selected personal information products. Warfighter Visualization is a program to demonstrate the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters.

(U) The Microwave and Analog Front End Technology (MAFET) program is the only DoD effort directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities. It will provide urgently needed improvements in the performance and affordability of microwave and millimeter wave components. The MAFET program addresses the essential foundation for all DoD systems and programs making use of microwave and millimeter wave solid state technology.

(U) The Centers of Excellence program finances demonstration, deployment of and training on advanced manufacturing technologies. The goal of this technology is to reduce unit and life-cycle costs while improving quality.

(U) The goal of the Manufacturing Technology Applications program is to reduce the cost and acquisition leadtime of future military systems by integrating manufacturing process considerations during the product design phase, and by demonstrating high efficiency multi-product prototype factories. This program will also enable manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies.

(U) Advanced Lithography technology has enabled the dramatic growth of integrated circuit capability. Advances have led directly to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability.

(U) The mission of the Computer-aided Acquisition and Logistic Support program is the transfer of Electronic Commerce technologies to small- and medium-size enterprises through a network of regional deployment centers.

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(U) The Microelectromechanical Systems (MEMS) project was previously included in MT-04, the Electronic Module Technology Project. This program is a broad and cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components, and integrated microelectronics to the design and construction of integrated electromechanical systems. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards, and physiological states.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
IR Focal Plane Array MT-03	39,493	23,995	9,000	14,000	0	0	0	0	0	N/A

(U) **Mission Description**: The Infrared Focal Plane Array project addresses the technology necessary to produce affordable, infrared (IR) sensor arrays, essential to major weapon systems. The focal plane array consists of a two dimensional detector array sensitive in a broad spectral range, integrated with unique signal processing to enhance performance and provide more efficient utilization of the information. The critical elements of the technology addressed in this program include the infrared material, detector array fabrication, read-out electronics, cryogenic packaging and testing, and module assembly. Processing and fabrication techniques focus on the production of affordable arrays, at low volume, in the configurations required by weapon systems. Performance enhancements in uncooled infrared and near-infrared sensors are also being addressed to provide an integrated, broadband two dimensional sensor array without the cryogenic package usually associated with infrared sensors. Elimination of the cryogenic package dramatically reduces the cost of the sensor module, and provides a sensor package compatible with a wide range of system applications, including navigation, targeting and manportable systems. The solid state integrated sensor also solves the problem of blooming in the presence of high intensity sources, which is encountered with current low light level visible and near infrared sensors. Arrays will be built in the configuration required for missile seekers; target acquisition and navigational platforms; search and track; and threat warning systems.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Completed development of standard electronic cells for rapid design and fabrication of infrared read-out circuits. ($9.0M)
- Demonstrated uncooled focal plane arrays hybridized to low noise analog readout circuits. ($5.0M)
- Demonstrated focal plane array fabrication using four inch diameter silicon wafers. ($14.0M)
- Verified computer aided design tool for infrared sensors; including cryogenic packaging. ($11.5M)

(U) FY 1997 Program:

- Complete single-wafer IRFPA processing on six inch silicon wafers. ($6.0M)
- Demonstrate capability to fabricate uncooled infrared sensor with one million pixels. ($5.5M)
- Assess capability to fabricate thin film ferroelectric uncooled infrared sensor. ($4.0M)
- Evaluate imaging performance and anti-blooming of uncooled solid state sensor. ($8.5M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-03

(U) FY 1998 Program:

- Demonstrate uncooled infrared array with thermal sensitivity of 0.05 degrees. ($4.0M)
- Demonstrate low light level solid state imager with anti-blooming protection. ($5.0M)

(U) FY 1999 Program:

- Fabricate and test integrated uncooled infrared array and solid state, low light level array with anti-blooming protection. ($10.0M)
- Establish feasibility of a solid state imager with spectral response beyond night vision goggles. ($4.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	36.7	24.0	9.0	14.0
Appropriated	35.8	N/A	N/A	N/A
Current Budget	39.5	24.0	9.0	14.0

(U) **Change Summary Explanation**:

FY 1996 Increase is due to increased uncooled technology efforts.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Demonstrate equipment with flexibility to produce various infrared focal plane array configurations on the same line.
Sep 96	Demonstrate large-area staring and scanning array for search and track, target acquisition, and missile seeker systems.
Mar 97	Demonstrate gain stage integrated into the pixel unit cell.
Sep 97	Evaluation of high performance uncooled sensor array.

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Sep 98 Evaluation of large area uncooled sensor with less than 0.05 degree thermal sensitivity.
Sep 99 Evaluation of integrated sensor with broad band infrared response.

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PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Module Technology MT-04	96,674	66,149	73,206	97,590	150,760	188,012	195,140	199,525	Continuing	Continuing

(U) **Mission Description:** The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog, and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards and emerging technologies such as high density Multichip Modules (MCMs).

(U) The project has four major objectives: (1) shorten the overall design, manufacture, test, and insertion cycle for advanced electronic subsystems; (2) advance the state-of-the-art in electronic interconnection and physical packaging technology to allow circuits to operate close to their intrinsic maximum speed with less overhead in terms of volume, weight and cost; (3) provide a robust manufacturing infrastructure for electronic modules; and (4) demonstrate the system level payoff of electronic module technology through advanced technology demonstrators (ATDs).

(U) The project has the following major elements: Application Specific Electronic Modules (ASEM); Multichip Integration (MCI); Rapid Prototyping of Application Specific Signal Processors (RASSP); Optical Micro-Networks (OMNET); Cooperative Adaptive Payloads (CAPS); Infrared Artificial Dielectrics (IRADs); and Design Support for mixed Technology Integration (Composite CAD). ASEM will reduce the non-recurring engineering time and cost for designing and inserting complex electronic modules. MCI will produce order of magnitude reductions in manufacturing cost and accelerate the acceptance and insertion of Multichip Integration technologies. RASSP is a major DARPA/tri-Service initiative which seeks to dramatically reduce the development time and life cycle cost of advanced signal processing capability. OMNET seeks to demonstrate new paradigms for integrating electronic, electromechanical, and electro-optical components to enable small, lightweight, battlefield information systems. CAPs is a new effort to integrate developments in MEMS, power sources, communications, and advanced microelectronics to design, construct and field multiple, high-performance, mobile, autonomous systems. IRADs will develop a new class of infrared materials that present very low radiative emissivity in (window) bands where the atmosphere is largely transparent and very high emissivity into bands where the atmosphere is opaque. Composite CAD seeks to enable the design of systems incorporating emerging micro-devices and manufacturing processes by developing the design technology (tools, methodology, and architectures) to support device and systems design of mixed-technology integrated systems.

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(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Completed development of required microwave packaging approaches and interconnection circuitry; produce and demonstrate required multichip microwave assemblies. ($10.2M)
- Demonstrated complete end-to-end Rapid Prototyping of Application Specific Signal Processors (RASSP) design framework with additional demonstration hardware and benchmark evaluations. Developed accelerated framework standards, improved Computer Aided Design (CAD) technology for system testing, and reuse libraries. Accelerated technology transfer activities. ($34.9M)
- Continued Application Specific Electronic Modules (ASEM) program to reach one month turn-around time and $25K non-recurring engineering (NRE) cost for digital Multichip Modules (MCMs). Demonstrate high volume production technology for producing known-good die. ($21.5M)
- Continued Multichip Integration (MCI) program with the delivery of high volume/low cost laminate MCM technology and develop optimized modules and mixed signal applications. ($20.1M)
- Expanded the current effort in Seamless High Off-Chip Connectivity (SHOCC) to include a full scale demonstration of a high-performance microprocessor. This demonstration segmented the integrated circuit design into yield and performance-optimized active elements, fabricated these elements and assembled a fully-functional device on a passive substrate incorporating traces formerly within the chip. Mating of the active die to the substrate was through a high-density interposer. ($10.0M)

(U) FY 1997 Program:

- Demonstrate final end-to-end RASSP signal processor design environment. Complete technology insertion demonstrations, benchmarking analysis, and technology transition activities. ($7.5M)
- Continue ASEM technology development and demonstrate new ASEM foundry capability for flexible production of modules with board-level integration. ($19.4M)
- Continue Multichip Integration program to demonstrate order of magnitude reductions in MCM manufacturing costs and MCM technology insertions. Continue insertion of MCM technology into dual-use products such as workstations, engine control and wireless communications. ($27.8M)
- Initiate OMNET program to demonstrate new paradigms for integrating electronic, electromechanical, and electro-optical components to enable small, lightweight, battlefield information systems. ($11.5M)

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(U) FY 1998 Program:

- Complete ASEM program to reduce non-recurring engineering cost for designing and inserting complex electronic modules. ($4.0M)
- Complete the Multichip Integration (MCI) program to demonstrate cost reductions in Multichip Modules (MCM) manufacturing costs and technology insertions. ($19.0M)
- Optical Micro-Networks (OMNET) - Downselect amongst heterogenous integration technologies and demonstrate multi-functional integration of electronic, electro-mechancial and optoelectric components targeted to military information systems. ($14.0M)
- Cooperative Adaptive Payloads (CAPs) - Initiate effort to put together in one package low-weight (<2 kg), high-performance payloads including sensors, imagers, countermeasures, designators, communications, and munitions. ($9.0M)
- Infrared Artificial Dielectrics (IRADs) - Initiate effort to develop candidate polymers using advanced lithography techniques. ($3.0M)
- Composite CAD - Initiate technology to support design of composite electronic systems composed of hundreds to millions of tightly coupled, mixed-technology devices. ($16.2M)
- Far Reach - Explore technology for ultra-low power, high bandwidth, stealthy battlefield wireless communications capability. ($8.0M)

(U) FY 1999 Program:

- OMNET - Demonstrate integrated optoelectronic transceivers and optical switches for reconfigurable interconnections of sensors to processors and the ability to distribute computation across military platforms 1-100 meters in length for future Electronic Warfare/digital radar and image processors. ($14.0M)
- CAPs - Construct the unit platforms, integrate commercial or demonstrated technology elements (e.g., imagers, MEMS, wireless systems), and field packs/herds of units to demonstrate multiple, cooperative functions. ($19.0M)
- IRADs - Continue polymer development using advanced lithography techniques. ($3.0M)
- Composite CAD - Continue to develop the mixed domain (kinematic, electric, electrostatic, and fluidic) analysis of micro-machined devices, systems of devices and corresponding electronic circuits to support the design of composite systems. ($32.6M)
- Far Reach - Continue development of spread-spectrum wireless communications for battlefield applications. ($18.0M)
- Explore new effort on developing technology for ultra-small, low cost multi-cast digital receiver. ($11.0M)

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(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	134.5	66.2	93.2	144.8
Appropriated	136.7	N/A	N/A	N/A
Current Budget	96.7	66.2	73.2	97.6

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects: Creation of a separate MT-12 MEMS Project for greater program visibility (-$31.0 million); Bosnia reprogramming funding source ($-5.8 million); and internal reprioritization of programs (-$3.2 million).

FY 1998-99 Decrease reflects revised DOD priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Complete high density microwave packaging final development of housings, interconnect approaches and perform initial module testing.
Jul 96	Demonstrate Application Specific Electronic Modules (ASEM) Technology for assuring known-good die.
Sep 96	Deliver Multichip Integration (MCI) Manufacturing Technology to the dual-use market.
Dec 96	Demonstrate Multichip Modules (MCM) insertions in small diameter missile.
Jun 97	Demonstrate final end-to-end Rapid Prototyping of Application Specific Signal Processors (RASSP) signal processor design.
Sep 97	Demonstrate new mixed signal ASEM foundry capability.
Jun 98	Demonstrate efficient 3-D electromagnetic modeling capability.
Aug 98	Complete testing of integrated optoelectronic devices.
Sep 98	Demonstrate MCM substrates with integrated passive components.

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Jul 99	Demonstrate mixed energy domain analysis capability for integrated technology devices.
Aug 99	Demonstrate optical micronetwork with reconfiguration capability.
Nov 99	Initial prototype of tightly integrated adaptive payload technology.

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PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tactical Information Systems MT-05	20,912	19,076	34,884	35,646	31,000	27,500	27,500	27,500	Continuing	Continuing

(U) **Mission Description**: This project is a major DoD effort to develop the technology for displays and portable information systems for use in a variety of military systems. The project has three major programs: Head Mounted Displays (HMDs), Smart Modules, and Warfighter Visualization. The Head Mounted Display program is developing world-class miniature displays and integrating these displays into head and helmet mounted configurations for use by pilots, combat vehicle crews and individual warriors as well as for virtual environments and simulation. Smart Modules is a program to design and develop prototype modules, using core technologies that sense, think, and communicate, and integrate them into selected personal information products. Warfighter Visualization is a program to demonstrate the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Head Mounted Displays. ($10.4M)
  - Completed all on-going miniature display efforts and initiated feasibility demonstrations for miniature diffraction grating displays and Microelectromechanical Systems (MEMS) based displays.
- Smart Modules. ($10.5M)
  - Demonstrated four systems for use by individuals remotely located from conventional information sources. Initiated developments to demonstrate individual worn direction finding and video capture capability.

(U) FY 1997 Program:

- Head Mounted Displays. ($8.0M)
  - Demonstrate feasibility of diffraction grating and MEMS based miniature displays. Diffraction grating displays will integrate drivers, standard interfaces, memory and controller circuitry directly on the display. This will improve the range of applications for which the display can be applied and significantly reduce power consumption requirements. The MEMS display will use a novel micro-beam steering device to control the movement of a fiber optic to scan a mirror with an image. This type of display will greatly reduce the head-borne weight to a few ounces and significantly reduce power consumption over currently available displays.

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- Smart Modules
  - Demonstrate the feasibility of combining computation, wireless communicating capability, and high resolution display in a paper sized device operating on commercially available batteries. Device will be built using shape deposition manufacturing processes to demonstrate rapid, cost-effective prototyping. The device will be used to receive text, graphics and video and provide limited transmitting capability. Demonstrate electronic information capability integrated into soldier's clothing. A soldier's vest will incorporate computers, GPS, radio, batteries and PC card slots for various peripherals. First demonstration will be for Army maintenance application. ($11.1M)

(U) <u>FY 1998 Program:</u>

- Smart Modules
  - Demonstrate prototype electric countermeasures system integrated into a solider worn vest. The computational capability developed in the FY 1997 program will be augmented with two PC cards containing ECM circuitry and will allow dismounted soldiers to instantly locate radio emissions from hostile forces. Demonstrate prototype water proof computer for underwater use by SEAL and Explosive Ordnance Disposal applications. ($15.3M)
  - Demonstrate prototype inertial navigation device integrated into soldier boots. This device will use miniature accelerometers and gyros to measure direction and distance traveled. It will be used to augment GPS navigation when the user is in areas where satellite reception is unavailable. ($6.1M)
- Warfighter Visualization
  - Initiate efforts to develop technologies that will allow tracking of hand and head motion for a mobile, untethered individual. Tracking head movement will allow a computer to display information to a head mounted display that is registered in the geospatial direction that the individual is looking. Tracking hand motion will allow a computer to recognize pointing and gestures as input mechanisms instead of using a keyboard. ($6.2M)
  - Demonstrate image capture and geospatial registration of icons on terrain in a moving vehicle. The vehicle will be equipped with video cameras that provide a 360 degree view. Inside the vehicle, a person wearing a head tracked, head mounted display will be a look around and view the images obtained from the cameras. Icons and graphical images generated by a computer will be overlayed on the camera image in the head mounted display. These images will be registered with the viewed real-world terrain. ($7.3M)

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(U) FY 1999 Program:

- Smart Modules
  - Demonstrate a novel capture device that incorporates signal and data processing in a 3-D package for use by individual soldiers. This miniature device weighing only a few ounces will be able to capture an image and rapidly analyze movement or correlate images with all processing done on the focal plane. The camera will be able to be worn by individual soldiers and communicate via a radio to and from geographic information system data bases. ($9.2M)
  - Demonstrate a wearable computer incorporating wireless communication in a one pound, one watt configuration. This represents a 3x improvement in weight and a 10x improvement in power over current technology. The wearable computer will be used in a wide variety of applications by the small unit operations soldier. ($9.0M)
- Warfighter Visualization
  - Demonstrate prototype capability for dismounted solider to view real world with overlayed graphic symbology. This capability will allow the soldier to receive visual information that is relevant to his/her mission time or location. It will also allow the soldier to interrogate data bases containing information about the specific objects in his/her viewing environment. ($5.8M)
  - Demonstrate prototype "see-through" tank concept. This capability will allow a "buttoned-up" tank crew wearing head mounted displays to view the outside world as though the tank were made of glass. This will be accomplished by placing cameras on the outside of the tank that provide inputs to a mapped memory. Images will be fed to the users head mounted display depending upon the direction that the user is looking. This capability will significantly enhance the situation awareness of the tank crew. ($6.5M)
  - Demonstrate a capability to obtain one-dimensional and two-dimensional data from a submarine sensor suite and configure these data into a 3-dimensional image covering 360 degrees that is provided to a head-tracked, head mounted display. This capability will be used by a submarine conning officer to demonstrate an enhanced capability for under ice submarine navigation. ($5.1M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	20.2	19.1	22.8	21.6
Appropriated Budget	19.6	N/A	N/A	N/A
Current Budget	20.9	19.1	34.9	35.6

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(U) **Change Summary Explanation**:

FY 1996 Increase reflects minor repricing.
FY 1998-99 Increase reflects new effort in Warfighter Visualization.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jul 96	Complete low voltage electroluminescent (EL) project.
Nov 96	2560 x 2048 pixel displays demonstration.
Jan 97	Integrated CCD, memory, wireless interface in Technology Advanced Mini Eyesafe Rangefinder (TAMER).
Feb 98	Demonstrate low power display.
Mar 98	Demonstrate air combat air controller modules.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microwave and Analog Front End Technology MT-06	39,858	47,921	48,071	39,000	25,000	0	0	0	0	N/A

(U) **Mission Description**: Microwave and millimeter wave technology for DoD electronic weapon systems is at a critical crossroads. Great progress has been made under the microwave and millimeter wave integrated circuit (MIMIC) program in terms of maturing the gallium arsenide industrial community. The DoD is now far ahead of the commercial world in microwave and millimeter wave technology in terms of performance characteristics. However, in many cases, radio frequency (RF) sub-system costs are still a major impediment to fielding DoD weapon systems. Material, processes and design technology advances must be undertaken to sustain an effective defense capability and to maintain U.S. dominance in this critical technology area. The Microwave and Analog Front End Technology (MAFET) program is the only DoD effort directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities and advanced technologies. It will provide urgently needed improvements in the performance and affordability of microwave and millimeter wave components. The MAFET program addresses the essential foundation for all DoD systems and programs making use of microwave and millimeter wave solid state technology.

(U) Specifically, the MAFET program will provide the DoD with the state-of-the-art electronic systems that it needs to maintain its force multiplying capability. The program will: (1) reduce design time and cost for every RF system being developed or upgraded through an improved microwave/millimeter wave design environment; (2) break the very expensive cycle and time-consuming current practice of design-build-test--redesign-rebuild-retest; (3) put in place repeatable, robust processes to produce high frequency components; (4) make strategic investments in critical passive, packaging and integrated circuits devices needed for millimeter wave systems; and (5) investigate revolutionary solutions to the long-standing problem of insufficient power in solid-state radar and communications transmitters.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Continued development and implementation of microwave/millimeter wave computer aided design (CAD) environment with quantitative demonstration of ability to reduce time and cost of producing microwave and

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millimeter wave products. Continued development and implementation of Microwave Hardware Description Language (MHDL). ($8.0M)

- Continued development of advanced sensor technology with demonstrations of improved performance coupled with cost savings. Demonstrate state-of-the-art millimeter wave probes. ($25.6M)
- Selected most appropriate system application areas and began demonstration tasks that will allow quantitative assessment of subsystem and system performance improvements and cost savings resulting from Microwave and Analog Front End Technology (MAFET) activities. Began benchmark development and assessment of design tool advances. ($3.1M)
- Investigated novel concepts, methodologies, and passive components for high-power, ultra-low-cost, all-solid-state microwave sources and high millimeter wave sources. ($3.2M)

(U) FY 1997 Program:

- Continue microwave/millimeter wave computer aided design environment development with implementation of advanced microwave/millimeter wave CAD tools and integrated tool sets and implementation of improved models. Conduct assessment and demonstration of design environment effectiveness through quantitative assessment of benchmarking metrics. Continue development and implementation of MHDL. ($15.2M)
- Complete advanced sensor technology developments in the area of millimeter wave test. In addition, demonstrate: (1) millimeter wave InP high electron mobility transistor (HEMT) monolithic microwave integrated circuits (MMICs) with high yield; (2) low cost, high Indium-content field effect transistor (FET) materials on gallium arsenide; (3) microwave and millimeter wave device arrays; (4) advanced mixed signal chips for highly integrated frequency synthesizers; (5) low cost MMIC components for electronic warfare transmitter arrays; (6) miniaturized microwave and millimeter wave ferrite circulators; (7) automated millimeter wave load pull test station; and (8) on-wafer known good die test station. Continue development of remaining advanced sensor technology with demonstrations of improved performance coupled with cost savings. ($19.5M)
- Begin development of all-solid-state X-band source with high output power and low fabrication cost. ($5.5M)
- Begin development of all-solid-state quasioptical Ka-band source with high output power. ($5.0M)
- Demonstrate MEMS X-band phase shifter technology at high power and ultra low loss. ($1.5M)
- Begin development of MEMS controlled beam-steering module at mm-wave frequencies. ($1.2M)

(U) FY 1998 Program:

- Complete microwave/millimeter wave computer aided design environment. Demonstrate design environment effectiveness. Continue implementation of MHDL. ($9.2M)

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- Complete advanced sensor technology developments in the areas of: advanced fabrication, packaging, and multichip assembly (MCA) foundries. In the fabrication area, demonstrate: (1) production InP HEMT and HBT millimeter wave processes; (2) advanced manufacturing processes for: high power and high efficiency, high dynamic range, and mixed signal capability; and (3) highly manufacturable and reliable HBT high power amplifiers. In the packaging area, demonstrate: (1) a 10x cost reduction in plastic HDI module fabrication technology; and (2) a 7x volume efficiency increase due to embedded transmission lines and advanced multilayer interconnect. In the foundry area, demonstrate a 5x reduction in MCA production cost. ($8.6M)
- Demonstrate all-solid-state X-band source with 100-W output. ($12.4M)
- Demonstrate all-solid-state quasioptical Ka-band source with 10-W output. ($10.2M)
- Integrate MEMS phase shifter with power amplifiers to make highly efficient X-band T-R modules. ($4.0M)
- Demonstrate MEMS-based beam steering array at frequencies above 30 GHZ. ($3.6M)

(U) FY 1999 Program:

- Insert and validate performance of 100-W X-band source in fielded ground-based-radar or similar platform. ($11.5M)
- Insert and validate performance of MEMS-based T-R modules. ($4.0M)
- Demonstrate millimeter wave 10-W all-solid-state quasioptical power in laboratory system or sub-systems. ($10.0M)
- Demonstrate millimeter wave MEMS-based beam steerer as replacement to gimbal-mounted mirror in laboratory missile-seeker subsystem. ($4.0M)
- Initiate high efficiency, low power, RF-analog merged process and circuit development efforts to achieve major advances in the cost, size, weight, and power of sensor electronics for space-limited platforms and man-portable systems. ($9.5M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	50.7	47.9	50.9	28.2
Appropriated	42.6	N/A	N/A	N/A
Current Budget	39.9	47.9	48.1	39.0

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(U) **Change Summary Explanation**:

FY 1996 Decrease due to reprogramming action in support of Bosnia.
FY 1998-99 Adjustment reflects program rephasing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Standard model format for foundries; benchmark of baseline system.
Jul 96	Fabricate and test InP millimeter wave integrated circuits.
Mar 97	Standard for simulator and design environment interoperability.
Mar 97	Produce broadband electronic warfare multichip assemblies.
Jun 97	Demonstrate millimeter wave test probes and automated on-wafer test station.
Sep 97	Demonstrate high power MEMS phase shifters.
Mar 98	Demonstrate 100-W X-band all-solid-state sources.
Sep 98	Demonstrate 10-W millimeter wave power amplifier array.
Mar 99	Demonstrate millimeter wave beam steering module.
Jun 99	Demonstrate > 100-W low cost X-band electronically steerable source.
Sep 99	Demonstrate 10-W millimeter wave all solid state transmitter subsystem.
Sep 99	Demonstrate full interoperability of CAD vendors.

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PE 0603739E, Project MT-07

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Centers of Excellence MT-07	16,884	14,000	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** This project provides funding for Centers of Excellence including the Robert C. Byrd Institute for Advanced Manufacturing at Marshall University, and the Focus: Hope National Center for Advanced Technologies (NCAT). The purpose of these Centers is to demonstrate, deploy and provide advanced manufacturing technology to significantly reduce unit production and life cycle costs, improve product quality, and deploy manufacturing training systems.

(U) The Institute for Advanced Flexible Manufacturing provides both a teaching factory and initiatives to local area industries to utilize computer-integrated manufacturing technologies and managerial techniques to improve productivity and competitiveness. The National Center for Advanced Technology (NCAT) is a component of the Focus: Hope Project whose purpose is to train technicians/engineers in advanced manufacturing processes and methods, demonstrate state-of-the-art flexible manufacturing and serve as a testbed for emerging manufacturing research.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Focus: Hope. ($12.9M)
  - Developed software to integrate 3D computer models with numerically controlled machine tools, and demonstrate its production capability.
  - Demonstrated an electronic (digital) library in the context of education and training of machinists.
- Institute for Advanced Flexible Manufacturing. ($4.0M)
  - Developed, demonstrated and evaluated new technologies for insertion and transfer to manufacturing centers and industry, with a focus on small- to medium-sized manufacturing companies.

(U) FY 1997 Program:

- Focus: Hope. ($10.0M)
  - Continue development and demonstration of software to integrate computer models with numerically controlled machine tools.
  - Continue efforts to demonstrate a digital library to enhance the education and training of machinists.

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- Institute for Advanced Flexible Manufacturing. ($4.0M)
  - Continue the on-going technology development that includes technology evaluation, research into dual-use flexible manufacturing and technology transfer to local business at the Institute for Advanced Flexible Manufacturing.

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	23.6	14.0	0	0
Appropriated	18.8	0	0	0
Current Budget	16.9	14.0	0	0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming action.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Oct 96	Develop, demonstrate and evaluate technology insertion and technology transferred to medium and small manufacturing companies.

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DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Manufacturing Technology Applications MT-08	59,507	34,051	33,455	25,000	21,951	10,000	10,000	10,000	Continuing	Continuing

(U) **Mission Description:** Future military systems will be affordable only if the manufacturing process is considered as an integral part of product design, production takes place in flexible, multi-product factories, and if advanced manufacturing technology is combined effectively with advanced business practices. This program focuses on demonstrations of process technology combined with innovative industrial practices, and will measure the improvements in cost, schedule and quality achievable in key defense product areas. Three major initiatives are included in the FY 1996-1999 program: Affordable Multi-Missile Manufacturing (AM3); Agile Manufacturing Pilot Programs; and the DARPA/Tri-Service Flexible Interferometric Fiber Optic Gyroscope (IFOG) Manufacturability Program.

(U) The Affordable Multi-Missile Manufacturing (AM3) program is an Advanced Technology Demonstration initiated in FY 1995. The objective of AM3 is to demonstrate the feasibility of 25-50% reductions in the unit cost of tactical missiles, both in ongoing missile production programs and in new missiles and major modifications. This will be accomplished by teams of missile prime contractors, component suppliers and manufacturing equipment and software vendors who develop and demonstrate the combined effects of advanced design, manufacturing, assembly systems and processes, missile value engineering changes, and acquisition reform and business practice innovations. A major technical theme is to achieve economies across a mix of missiles to compensate for the decline in individual missile quantities. Demonstrations will be conducted in the design and manufacture of components and guidance and control/seeker assemblies for multiple missiles, including R&D and production programs.

(U) Agile Manufacturing is an industry-developed vision for 21st century manufacturing, which focuses on the ability to thrive in an environment of changing product technologies, customer demands, and development and production team members. This new paradigm is ideally suited to the needs of defense manufacturing in the future. Agile Manufacturing Pilot Programs are structured to evaluate the manufacturing enterprise concepts and enabling technology required for agility on and above the factory floor. Since over 50% of the cost of weapon systems is attributable to components from lower tier suppliers, the major emphasis is on tightly integrating the supplier chain and other elements of the manufacturing enterprise.

(U) Interferometric Fiber Optic Gyroscopes (IFOG) are emerging as preferred technology for future military and commercial inertial navigation applications. The emphasis of the IFOG Manufacturability Program is on achieving the

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design and manufacturing flexibility required to make low volume Defense components economically viable when compared to high volume commercial production. This program will develop the large throughput robotic assembly, packaging and testing technologies necessary to fabricate navigation-grade (0.01 deg/hr) Interferometric Fiber Optic Gyroscopes (IFOGs) at less than $1,500 per axis as a goal. This will enable affordable, accurate (1nm/hr) inertial navigators for use during extended periods of Global Positioning System (GPS) signal outage due to enemy jamming. Flexible manufacturability enables, from the same production line, fabrication of navigation grade, military tactical grade (0.1 - 1.0 deg/hr) IFOGs and lower performing (> 1 deg/hr) commercial IFOGs. Example technology development areas include: (1) low loss, low reflectivity, polarization-preserving optical connections between optical fiber subassemblies, optical sources, detectors and miniature integrated optical circuits; (2) rapid, precision coil winding machines; (3) geometrically stable, environmentally robust (temperature and vibration) packaging of critical optical subassemblies; and (4) automatic testing machines. Phase 1 will identify IFOG manufacturing process requirements for components, subassemblies and complete IFOG units. Phase 2 will demonstrate advanced manufacturing methods, controls and equipment. Phase 3 establishes and demonstrates a prototype automated, flexible IFOG manufacturing facility, transitioning the manufacturing processes and controls from Phase 2.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Affordable Multi-Missile Manufacturing (AM3). ($23.7M)
  - Completed Affordable Multi-Missile Manufacturing (AM3) Phase 1, approved validation plans, and initiated Phase 2 demonstrations to assess and mitigate risks, including simulation and modeling, design and component-level manufacturing demonstrations, and qualification testing.
  - Solicited proposals from research labs, universities and manufacturing system vendors for the development of technologies to fill gaps identified in AM3 Phase 1.
  - Continued AM3 technical integration activities, conducted independent evaluation of contractor cost savings analyses and completed initial set of benchmark comparison studies for the missile sector.
- Agile Manufacturing Program. ($16.4M)
  - Completed Agile Manufacturing business practice demonstrations and documentation, inserted results in Pilot Program testbeds, and disseminated results for DoD and industry implementation.
  - Completed Agile Manufacturing enabling technology demonstrations, initiated beta test in Pilot Programs, and transferred technology through the Industry Forum and through vendor products.
  - Completed Agile Manufacturing pilot programs in space launch vehicles and castings.

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- Completed Agile Manufacturing industry forum activities, including delivery of agility toolkit and knowledge base, and transition to self-sustainment.

• Interferometric Fiber Optic Gyroscope (IFOG). ($19.4M)
- Developed and implemented manufacturing processes for coil winding and optical components/subassemblies.
- Completed IFOG architectures and began to develop and implement manufacturing processes.

(U) FY 1997 Program:

• Affordable Multi-Missile Manufacturing (AM3). ($12.2M)
- Complete AM3 Phase 2 component-level validation demonstrations.
- Competitively select at least two pilot enterprises for AM3 Phase 3, and initiate cost-shared implementation and demonstration of concepts and technology across the target missile mix.
- Complete initial demonstrations of technologies to fill gaps identified in AM3 Phase 1, expand benchmarking studies, and continue technical integration and independent cost analysis.

• IFOG. ($21.9M)
- Evaluate wound coils and packaged subassemblies for IFOG.
- Continue to implement brassboard Interferometric Fiber Optic Gyroscopes (IFOG) unit manufacturing processes.
- Initiate Phase 3 of IFOG program (e.g., procure long-lead items).

(U) FY 1998 Program:

• Affordable Multi-Missile Manufacturing. ($25.0M)
- Continue AM3 Phase 3 implementation of new factory systems and new business practices in two pilot enterprises.
- Complete initial design and test planning for AM3 multi-missile components and value engineering change proposals.

• IFOG. ($8.5M)
- Demonstrate flexible production of navigation grade and tactical grade IFOG units.
- Demonstrate production of packaged optical sources and automated optical fiber connections.

(U) FY 1999 Program:

• Affordable Multi-Missile Manufacturing. ($25.0M)
- Continue AM3 Phase 3 implementation of flexible multi-product assembly cells and prototype production of missile hardware.

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- Conduct initial tests of missile seekers built with the Affordable Multi-Missile Manufacturing (AM3) scalable family of parts and commercial components.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	78.9	34.1	33.5	25.0
Appropriated	67.3	N/A	N/A	N/A
Current Budget	59.5	34.1	33.5	25.0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects inflation savings cited on reprogramming actions and below threshold reprogramming action for SBIR.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jul 96	Complete proof-of-concept of fiber pigtailing for IFOG optics chips.
Sep 96	Complete Agile Manufacturing enabling technology and business practice demos.
Jul 97	Complete AM3 Phase 2 demos, downselect to two contractors for Phase 3.
Jul 97	Demonstrate production of novel wavelength stabilized IFOG light source.
Aug 97	Demonstrate winding of test coils with advanced coil winding machinery.
Aug 97	Demonstrate production of novel wavelength stabilized IFOG light source.
Oct 97	Complete IFOG advanced coil winding machinery.
Oct 97	Demonstrate winding of test coils with advanced coil winding machinery.
Mar 98	Demonstrate assembly of brassboard IFOG units.
Dec 99	Complete AM3 Phase 3 multi-missile manufacturing demos.
Jun 00	Complete flight tests of AM3 missile seeker prototypes.

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R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Lithography MT-10	46,109	51,404	40,000	40,000	40,000	40,000	37,500	35,754	Continuing	Continuing

(U) **Mission Description**: Lithography technology has enabled the dramatic growth in microelectronics capability over the past three decades and microelectronics is a key to improved weapon system performance. The improved capabilities in semiconductor technology contribute to significant system gains in speed, reliability, cost, power consumption, and weight. Advanced microelectronics technology is essential for computing and signal processing throughout essentially all military systems, including command, control, communications, and intelligence, electronic warfare, and beam forming for radar and sonar. Further improvements in areas such as target recognition, autonomous guided missiles, and digital battlefield applications require microcircuits with smaller features to meet the operational speed, power, weight and volume constraints of these systems.

(U) Current microelectronics fabrication utilizes feature sizes of 0.35 microns. The Advanced Lithography Program emphasizes longer term research with expected high payoff in the fabrication of semiconductor devices with 0.1 or less micron feature sizes. These programs will develop technology for sub 0.1 micron features. Current programs in cross-cutting technologies (mask, stages, resists, metrology) and x-ray lithography will be completed in one - two years. The projection e-beam developments will demonstrate alpha tool versions late in the decade.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:
- Demonstrated prototype projection electron-beam and ion-beam lithography lenses. ($10.0M)
- Demonstrated processing using x-ray lithography and point source development. ($23.0M)
- Developed alignment sub-assemblies and mask technology for 0.18 micron lithography system. ($13.1M)

(U) FY 1997 Program:
- Demonstrate stage control for lithography tools with 0.13 micron capability. ($6.0M)
- Demonstrate breadboard subsystems of electron-beam projection lithography systems. ($14.0M)
- Fabricate devices and x-ray sources for 0.13 micron design rules. ($25.0M)
- Improve e-beam writing, inspect, repair, and processing for 0.12 mask capability. ($6.4M)

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PE 0603739E, Project MT-10

(U) FY 1998 Program:

- Research efforts for sub 0.1 micron in maskless lithography (emitter arrays and photocathodes), innovative imaging materials, and network of university efforts in novel patterning. ($28.0M)
- Complete development on cross-cutting technology in precision stages and mask making (e-beam writing and inspection) for 0.13 - 0.10 micron features. ($12.0M)

(U) FY 1999 Program:

- Continue efforts in maskless lithography, including arrays of miniature e-beam columns, and novel imaging materials and pattern transfer processes. ($32.0M)
- Continue network of university efforts addressing potential show-stoppers with novel approaches in patterning, metrology, modeling, materials, and image placement. ($8.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	39.0	51.4	40.0	40.0
Appropriated	59.0	N/A	N/A	N/A
Current Budget	46.1	51.4	40.0	40.0

(U) **Change Summary Explanation:**

FY 1996 Decrease is due to recission of the Point Source X-Ray Lithography Program ($11.0 million) and the Bosnia reprogramming action ($1.9 million).

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan	Milestones
Jun 96	Demonstrate mask repair tool for masks with 0.15 micron features.
Sep 96	Fabricate devices with 0.18 micron features.
Jan 97	Demonstrate subsystems for mask writer for writing 0.18 micron features.

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Mar 97	Demonstrate x-ray source suitable for x-ray prototype tool for 0.18 micron features.
Mar 97	Demonstrate stage control to 10 nm, suitable for 0.12 micron lithography tools.
Apr 97	Demonstrate breadboard (alpha) version of electron-beam lithography system.
Dec 97	Demonstrate alpha version of ion-beam lithography tool.
Jun 99	Demonstrate switched emitter arrays for maskless lithography.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Commerce Resource Centers MT-11	31,073	20,704	15,000	0	0	0	0	0	0	N/A

(U) **Mission Description:** The mission of this program is the transfer of electronic commerce (EC) technologies to small- and medium-size enterprises (SMEs) through a network of regional deployment centers. This mission is a subset of the overall DoD plans for Continuous Acquisition and Life-cycle Support (CALS) and for electronic commerce as part of Acquisition Reform. To reflect the focus on that subset, the program name was changed in FY 1994 from CALS Shared Resource Centers to Electronic Commerce Resource Centers (ECRCs). In transferring EC technologies to SME's, the ECRC technical vision is that manufacturing companies will move down a path of increasing EC capability that ranges from linking suppliers with customers, via electronic data interchange, to the establishment of virtual enterprises. An ECRC technology hub has been established to keep abreast of EC technologies and to ensure that technical consultants in the regional ECRCs are equipped with the latest information and training on EC technologies.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Electronic Commerce Resource Centers (ECRC). ($31.1M)
  - Follow-on awards to current ECRC integrators to continue ECRC network of sites for nationwide delivery of education, training, and technical support services (Congressional direction).
  - Continued Technology Hub operations with initiatives for Electronic Commerce (EC) Testbed, and for advances in tools needed for development of STEP applications.

(U) FY 1997 Program:

- Electronic Commerce Resource Centers (ECRC). ($20.7M)
  - Continue operation of nationwide network of centers, and expand linkage to Defense Logistics Agency activities.

(U) FY 1998 Program:

- Electronic Commerce Resource Centers (ECRC). ($15.0M)
  - Complete DARPA funded ECRC technology development and deployment; transition program to DLA for continued operation.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-11

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	34.2	20.7	15.0	0
Appropriated	33.3	N/A	N/A	N/A
Current Budget	31.1	20.7	15.0	0

(U) **Change Summary Explanation**:

FY 1996 Decrease is due to Bosnia reprogramming.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Sep 96	Demonstrate value of networked access to ECRC services; train 3,000 companies to implement electronic commerce.
Sep 97	Expand training curriculum, focus on Defense Logistics Agency procurement activities and train 20,000 industry and government personnel nationwide.
Sep 98	Complete transition of ECRC activities to Defense Logistics Agency.

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BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microelectromechanical Systems (MEMS) MT-12	29,514	54,800	75,060	71,549	69,281	60,000	50,000	50,000	Continuing	Continuing

(U) **Mission Description**: The Microelectromechanical Systems (MEMS) program is a broad, cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components, and integrated microelectronics to the design and construction of integrated electromechanical systems. The MEMS program addresses issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards, and physiological states.

(U) The MEMS program has three principal objectives: the realization of advanced devices and systems concepts; the development and insertion of MEMS products into DoD systems; and the creation of support and access technologies to catalyze a MEMS technology infrastructure. These three objectives cut across a number of focus application areas to create revolutionary military capabilities, make high-end functionality affordable to low-end systems, and extend the operational performance and lifetimes of existing weapons platforms. The major technical focus areas for the MEMS program are: 1) inertial measurement; 2) fluid sensing and control; 3) electromagnetic and optical beam steering; 4) mass data storage; 5) chemical reactions on chip; 6) electromechanical signal processing; 7) active structural control; 8) analytical instruments; and 9) distributed networks of sensors and actuators.

(U) Accomplishments to date include: a wind-tunnel test of an integrated MEMS sensor and actuator array distributed along the leading edge of a model aircraft wing creating rolling moments of sufficient strength to control aircraft flight, pointing the way to future fighter aircraft with advanced maneuverability unattainable using conventional, large and discrete control surfaces; a demonstration of a MEMS-based accelerometer capable of surviving and operating in the near 100,000 G accelerations generated by firing artillery shells, making possible affordable guidance systems to what are presently unguided munitions and increasing both their effectiveness and life cycle

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costs; and the establishment of a regularly scheduled, shared, MEMS fabrication service for domestic DoD, commercial and academic users. The service has lowered barriers to access and has allowed hundreds of researchers, students and industrial users, nearly half for the first time, to inexpensively and rapidly fabricate MEMS devices.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Achieved factor of 3-5x increase in electronics-to-mechanics integration ratios with new fabrication processes; began development of related information-driven and fault-tolerant designs for devices; began incorporation of extreme condition materials into sensor and actuator designs. ($6.9M)
- Achieved 200-300 mechanical components/sq. cm systems densities with associated increases in both process yields and device performance uniformities; began exploration of new organization and control strategies for multiple, heterogeneous and distributed MEMS components; continued development of complete and stressing MEMS systems demonstration projects in areas such as fluid vortex control, adaptive optics, combustion control and atomic-resolution mass-data storage. ($16.7M)
- Extended distributed shared fabrication services to enable process experimentation; continued development of fabrication, packaging and metrology tools to address devices and systems developments; expanded available set of shared fabrication processes and associated CAD tools and design libraries. ($5.9M)

(U) FY 1997 Program:

- Achieve additional factor of 5-10x increase in electronics-to-mechanics integration ratios; explore space of related device designs and architectures enabled by order-of-magnitude increase in integration ratios including electromechanical signal processing elements and radio-frequency components; continue development of fault-tolerant and parallel designs including low-noise, low-drift multi-axis accelerometers and gyroscopes; demonstration of extreme temperature and pressure sensor function in operational environments. ($10.7M)
- Achieve 400-500 mechanical components/sq. cm systems densities with integrated or hybrid fabrication/assembly techniques; demonstrate MEMS applications using massively parallel MEMS components; initiate new dual-use areas including analytical instruments, precision assembly, on-demand structural strength enhancement and air-vehicle aerodynamic control; begin creation of shared testbed for development and validation of new organizational and control strategies for large-scale, distributed MEMS. ($23.2M)
- Begin transition of mature fabrication services to self-sufficiency; demonstrate scalable distributed fabrication services for MEMS process experimentation; continue development of MEMS-specific unit processes

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and associated processing equipment; continue the extension of simulators to address the modeling and coupling of multiple physical forces encountered in MEMS applications; continue dissemination and validation of CAD tools and design libraries. ($8.9M)

- Initiate plans to develop on-chip integrated microfluidic systems for improved detection and control of molecular reactions with emphasis on the development of new materials and control of reactions. ($12.0M)

(U) FY 1998 Program:

- Accelerate and expand on MEMS systems developments that; (1) exploit physics and MEMS systems architecture to project micro scale actions into macro scale effects, (2) extend present fabrication processes to cost-effective, large-area fabrication approaches, and (3) integrate developments in MEMS, robotics and ultra-electronics to design, construct and field multiple, high-performance, mobile, autonomous systems. ($57.1M)
- Initiate system-level integration through an evolving testbed strategy in which the development of new microfluidic components and processes occurs concurrently with the integration of early prototypes with available chip-based molecular analysis components. Leverage analysis and detection technology from industry, Services, and other DoD programs when compatible with microsystems integration. ($18.0M)

(U) FY 1999 Program:

- Initiate concept demonstrations for systems in the form of model aircraft and weight-supporting structures, and additional concepts in areas including identify friend-or-foe systems, on-chip chemical processing, and mobility. Address the key barriers in MEMS fabrication, packaging and integration to realizing systems demonstrations that will be critical to DoD validation and insertion of MEMS technology. ($55.5M)
- Continue system-level integration on new microfluidic components and processes. ($16.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	31.0	54.8	65.1	66.5
Appropriated	30.2	N/A	N/A	N/A
Current Budget	29.5	54.8	75.1	71.5

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(U) **Change Summary Explanation**:

FY 1996 Reduction reflects inflation savings used to finance Bosnia operations ($-.3 million) and transfer to SBIR PE ($-.4 million).

FY 1998-99 Increase reflects program in microfluidic systems and enhancements to MEMS.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	MEMS-based weapons safeing and arming tests.
Aug 96	Aerodynamic control of model airplane flight with distributed MEMS.
Oct 96	Microcombustion heat exchanger operation.
Mar 97	Navigation-grade inertial measurement and guidance devices.
Jun 97	VGA-resolution monochrome grating light-valve display.
Sep 97	25k Tracks/in magnetic recording with dual-stage actuators.
Jan 98	Self-sufficiency of mature shared fabrication services.
Jun 98	Controlled chemical reactions and processing on chip.
Jan 99	Atomic-resolution data storage using precision, multiple read/write structures.

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APPROPRIATION/BUDGET ACTIVITY
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R-1 ITEM NOMENCLATURE
Advanced Simulation-National Guard,
PE 0603744E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Simulation (National Guard) SM-01	4,887	0	0	0	0	0	0	0	0	N/A

(U) **Mission Description**: In FY 1992, Congress appropriated funds to initiate a program to apply advanced technology to the training of National Guard Roundout Brigades. This program was initiated to respond to issues that developed in the 1991 Desert Shield/Desert Storm mobilization.

(U) The program goal is to achieve the significant improvement in training effectiveness required for reserve component maneuver force mobilization through the use of advanced distributed information technologies and innovative training strategies at a lower cost than current active component methods for conducting the same training. The intent is to develop and integrate technologies that enable National Guard soldiers to conduct sophisticated training either at the local community armory, or at the soldier's home. The program will capitalize on existing commercial technologies where feasible, and concludes in FY 1996.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Operate one test brigade on the Defense Simulation Internet (DSI). ($.8M)
- Develop innovative training programs and delivery assessment technologies. ($1.2M)
- Continue development of desktop simulators and advanced technology distributed training capabilities and delivery technologies. ($1.1M)
- Continue development of measures of performance and conduct of program evaluation research. ($.9M)
- Complete program completion and final technical report. ($.9M)

(U) FY 1997 Program: N/A

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

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R-1 ITEM NOMENCLATURE
Advanced Simulation-National Guard,
PE 0603744E, Project SM-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	5.8	0	0	0
Appropriated	5.7	N/A	N/A	N/A
Current Budget	4.8	0	0	0

(U) **Change Summary Explanation**:

FY 1996 Reduction reflects minor repricing ($-.3 million), inflation savings used as reprogramming sources ($.-5 million), and transfer of SBIR funds to a separate program element ($-.1 million).

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Apr 96	Delivered last equipment simulators.
Apr 96	Completed fielding of ARSI Platoons (Phase II).
Aug 96	Evaluate first experimental brigade at the National Training Center (NTC).
Sep 96	Demonstrate initial links on DSI.
Oct 96	Complete Phase I Assessment Results/Recommendations.
Nov 96	Deliver modified training programs from FY 1996 NTC rotation.
Dec 96	Deliver final report.

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R-1 ITEM NOMENCLATURE
Semiconductor Manufacturing Technology, PE 0603745E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
SEMATECH EM-01	36,531	0	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** This project supports SEMATECH, a pre-competitive industrial consortium that addresses the long-term semiconductor manufacturing requirements for military applications. The goal of SEMATECH is to continue reducing costs while maintaining the state-of-the-art in complexity and performance for silicon technologies. It concentrates on future factory design and process definition and control efforts for flexible manufacturing of both low- and high-volume devices in the same factory. Environmentally conscious manufacturing, and safety and health of manufacturing personnel are also part of this effort. This project will combine advances in physical equipment with software advances, i.e., fully computer-integrated manufacturing (CIM) systems, and modeling and simulation tools for designing processes, tools, and factories. SEMATECH comprises the companies that supply the majority of the integrated circuits used in defense systems, and it has a proven track record of working with equipment suppliers effectively. FY 1996 is the final year of direct government funding.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Investigated equipment requirements, advanced process flows, and design tools for the 0.18µm device technology generation. ($16.2M)
- Initiated key equipment development efforts to provide early access to 0.18µm process capabilities. ($7.2M)
- Coordinated and analyzed the results of sophisticated physical experiments using external vendors to process silicon-on-insulator wafers for various suppliers. ($1.7M)
- Developed new approach to design of rapid-thermal process chambers that supports advanced process capabilities. ($3.0M)
- Developed neutral stream etch technologies. ($1.8M)
- Developed materials technologies for deposition of low dielectric constant materials. ($1.0M)
- Developed assembly and packaging technologies for cost-effective, high performance chip-to-package interconnection and robust manufacturing methodologies. ($2.0M)
- Investigated equipment and unit processes that have improved Environmental Safety Health (ESH) performance. ($3.6M)

(U) FY 1997 Program: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Semiconductor Manufacturing Technology, PE 0603745E, Project EM-01

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	89.6	0	0	0
Appropriated	37.9	N/A	N/A	N/A
Current Budget	36.5	0	0	0

(U) **Change Summary Explanation**:

FY 1996 Reduction due to reprogramming action in support of Bosnia ($-.9 million) and transfer to the SBIR program element ($-.5 million).

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 96	Demonstrate operation of key elements of a fully integrated advanced manufacturing system enabling maximum flexibility and rapid response to process modifications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Maritime Technology, PE 0603746E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Shipbuilding Technology MR-01	46,351	37,408	50,000	0	0	0	0	0	0	N/A

(U) **Mission Description**: The goal of the MARITECH Program is to preserve the U.S. shipbuilding industrial base by improving the industry's commercial competitiveness through advanced technology applications. For the Defense Department, a competitive shipbuilding industry optimizes Navy ship acquisition reform and allows realization of the Department's objective for affordable Navy ships. The goal of the DoD Acquisition Reform Program is to take advantage of the best commercial practices of industry and thereby achieve cost reductions of the ships and systems it purchases. Having operated exclusively in a protected domestic market, the U.S. shipbuilding industry has not implemented the best commercial processes necessary to compete in the international arena or to build affordable Navy ships. The government's attempt at acquisition reform, as it applies to ship acquisition, could fall short if U.S. shipyards are not commercially competitive. The key for acquisition reform is for the U.S. shipbuilding industry to attain global commercial competitiveness.

(U) This is a two phased program that provides products and infrastructure for the near and far term. The near term effort enhances international competitiveness through the development of a portfolio of U.S. ship designs for the international marketplace and the build strategies for their competitive price and delivery. This effort is being enhanced by developing an infrastructure that includes the implementation of electronic communications and commerce throughout the industry, and by participating in an industry-wide forum for problem solving on a technical level.

(U) The long term effort includes the infusion of innovative product technologies and process improvements that brings the capabilities of the U.S. shipbuilding industry above those of foreign shipyards. This will result in a larger share of the international market, and a self-sustaining, highly efficient U.S. shipbuilding industry.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Completed all shipbuilding strategy development initiatives and new ship designs begun in prior years. ($12.8M)
- Completed advanced technology development initiatives started in FY 1995. ($8.2M)
- Established a National Shipbuilding Consortium. ($.6M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Maritime Technology, PE 0603746E, Project MR-01

- Commenced Electronic Commerce Computer Integrated Enterprise for Maritime community development. ($3.7M)
- Continued to improve and expand National Shipbuilding Network (NSnet). ($.9M)
- Commenced new initiatives for advanced shipbuilding strategies and new commercial designs. ($4.5M)
- Commenced new initiatives for advanced technologies to radically improve ship production processes and products. ($9.4M)
- Investigated Applicability of Advanced Materials to hull construction. ($2.7M)
- Developed application protocols for ship design and shipboard automation. ($3.6M)

(U) FY 1997 Program:
- Initiate additional advanced technology developments for improving ship production processes and products. ($8.7M)
- Complete advanced technology developments started in FY 1996. ($12.2M)
- Continue to improve and provide support for National Shipbuilding Network (NSnet). ($.6M)
- Expand Electronic Commerce and Computer Integrated Enterprise. ($7.1M)
- Support National Shipbuilding Consortium. ($.9M)
- Complete advanced shipbuilding strategies and commercial ship design initiatives. ($7.9M)

(U) FY 1998 Program:
- Complete advanced product and process technology initiatives. ($25.0M)
- Complete Maritime Industry Electronic Commerce Designs. ($25.0M)

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	49.7	37.4	50.0	0
Appropriated	48.1	N/A	N/A	N/A
Current Budget	46.4	37.4	50.0	0

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Maritime Technology, PE 0603746E, Project MR-01

(U) **Change Summary Explanation**:

FY 1996 Decrease due to inflation savings cited on reprogramming actions ($-.9 million) and transfer to the SBIR program element ($-.8 million).

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Apr 96	Commence new initiative for Advanced Technologies to radically improve ship construction processes in the U.S. to surpass foreign competition.
Sep 96	Complete development of 19 new ship designs for the international commercial marketplace along with strategies for competitive construction.
Sep 97	Complete development of 15 process and product technological innovations focused on aiding the U.S. shipbuilding community to compete internationally.
Sep 97	Complete 9 additional ship designs for the international commercial marketplace.
Nov 97	Complete evaluation of Integrated Product Data Environment for Shipbuilding.
Feb 98	Complete test and evaluation of System Life Cycle Support Infrastructure Demonstration Project.
Sep 99	Complete development of commercialization plan for next Generation Windows^{tm} based system for Integrated Product and Process Development.
Dec 99	Complete development of National Shipbuilding Information Infrastructure Protocols.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Electric Vehicles,
PE 0603747E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electric Vehicles EV-01	14,694	0	0	0	0	0	0	0	0	N/A

(U) **Mission Description**: Electric and hybrid electric drivetrains provide compelling advantages for future tactical and combat vehicles. Of particular importance is a 50-percent reduction in fuel consumption due to higher efficiency, improved acceleration and maneuverability due to immediate torque to the wheels or tracks, and dramatically reduced thermal and acoustic signatures when operating from on-board energy storage. Affordability is addressed through reduced logistics requirements and the dual use applications of these technologies.

(U) The DARPA Electric and Hybrid Vehicle Technology program is pursuing research, development, and demonstrations of technologies for electric and hybrid vehicles that address military missions, modernization, and cost mitigation. Established by Congress in FY 1993, the program has pursued technology development and prototype demonstrations that are essential for future military systems, enhancing national energy security, and facilitating compliance by the Armed Services with federal clean air legislation. DARPA uses a unique decentralized management approach working directly with seven regional consortia. These diverse consortia provide a minimum of 50% of the funding and cooperatively function to overcome the challenges of developing electric and hybrid vehicle technologies. Their participants include military laboratories and bases, state and local governments, large and small defense contractors, well-established and startup manufacturers of vehicles and components, electric and gas utilities, public interest groups, and universities. Military requirements and infrastructure are implemented within this program at minimal federal investment, leveraging significant funds.

(U) Technology development is focused on: High-specific power engine/generator sets, including multi-fuel capable, high efficiency, and low emissions turbines, diesels, and rotary engines; Power control devices, including high-performance power semiconductors, control algorithms, and circuit integration and packaging; Energy storage devices, including advanced batteries, rapid battery recharging, flywheels, and capacitors; Electromechanical conversion, including alternating current and direct current, and linear motors; and Lightweight high-strength materials, including space-frames and composites. These dual-use electric drivetrain technologies are being demonstrated in both commercial and military chassis. The technologies are directly relevant and are coordinated with the DARPA Combat Hybrid Power System Program (EE-48) which is developing an integrated electric power system to provide both continuous and pulsed power to all of the subsystems on a combat vehicle including weapons, C3I, countermeasures as well as the electric drivetrain developed in this program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Electric Vehicles, PE 0603747E, Project EV-01

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Demonstrate hybrid electric drivetrains in Bradley Fighting Vehicle and High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and design drivetrain upgrade for Composite Armored Vehicles. ($1.7M)
- Demonstrate Upgraded M113 Armored Personnel Carrier and USMC/SOF Vehicle Drivetrains. ($1.8M)
- Demonstrate hybrid and electric drivetrains in 40 ft buses (1 ea.), 31 ft buses (3 ea.), 22 ft buses (3 ea.), delivery van (1 ea.), refuge truck (1 ea.) and 64 ft SWATH boat (1 ea.). ($1.8M)
- Develop flexible manufacturing technology and cost reduction practices for composite materials to support affordable, high strength, lightweight chassis. ($2.4M)
- Develop technology for affordable electric and hybrid vehicle drivetrains including: prime power, energy storage (high power batteries, flywheels and ultracapacitors) and motor/controllers. ($4.0M)
- Develop battery management systems, rapid battery chargers and technology for cold weather operations. ($3.0M)

(U) FY 1997 Program: N/A

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0	0
Appropriated	15.0	N/A	N/A	N/A
Current Budget	14.7	0	0	0

(U) **Change Summary Explanation:** N/A

FY 1996 Change reflects Bosnia reprogramming.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Electric Vehicles, PE 0603747E, Project EV-01

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jul 96	Demonstrate hybrid electric propulsion of a High Mobility Multi-purpose Wheeled Vehicle (HMMWV).
Sep 96	Demonstrate hybrid electric propulsion of a Bradley Fighting Vehicle.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Joint Strike Fighter Program, PE 0603800E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Joint Strike Fighter Program JA-01	28,917	78,400	0	0	0	0	0	0	0	N/A

*Funded under JAST program, PE 0603800N. Provided directly to DARPA from JAST.

(U) **Mission Description**: The Joint Advanced Strike Technology (JAST) Program is the focal point for defining affordable next generation strike aircraft weapon systems for the USN, USMC, USAF, and allies. Program emphasis is on facilitating the evolution of fully validated and affordable joint operational requirements, and demonstrating cost leveraging technologies and concepts to lower risk prior to entering engineering and manufacturing development (E&MD) of the JSF in FY 2001. The JAST Program is a joint program with no executive Service. Beginning in FY 1995, the Navy and Air Force each provide approximately equal shares of annual program funding. DARPA's Advanced Short Take Off Vertical Landing (ASTOVL)/Conventional Take Off and Landing (CTOL) Common Affordable Lightweight Fighter (CALF) project (previously known as ASTOVL) was integrated with the JAST program by FY 1995 legislation. DARPA contributes funding for the JAST Program in FY 1996 under this new program element. The US/UK international collaborative CALF Program conceived by DARPA was investigating a revolutionary approach for melding advanced technology, multi-service commonality, and improved business practices directed toward demonstrating an affordable, capable replacement for the F-16, F/A-18, and AV-8B. DARPA is bringing this insight and experience to bear in integrating the structure and philosophy of the CALF program within the JAST framework. The DARPA program manager now is serving as a Director within the JAST program organization. This ensures that DARPA's expertise in ASTOVL technologies, streamlined acquisition, and rapid prototyping are brought to bear in the JAST technology demonstration program.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Completed critical technology validation program for the Direct Lift and Shaft Coupled Lift Fan Concepts. ($7.4M)
- Commenced Preliminary Demonstration Design Propulsion and JAST Competitive Engine efforts. ($18.3M)
- Commenced concept definition and design research for weapon system concept for a tri-service family of aircraft. ($3.2M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE: May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Joint Strike Fighter Program,
PE 0603800E, Project JA-01

(U) FY 1997 Program:

- Commence Joint Strike Fighter Concept demonstration phase, including ground and flight demonstrations and concept refinement for the tri-service family of aircraft. ($78.4M)

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	30.7	78.4	-	-
Appropriated	29.9	N/A	N/A	N/A
Current Budget	28.9	78.4	-	-

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming ($-.3 million) and transfer of funds to the SBIR PE ($-.7 million).

(U) **Other Program Funding Summary Cost**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
PE 0603800F	81.2	263.8	431.1	458.5	238.9	18.8				
PE 0603800N	81.2	246.8	421.8	457.3	239.0	18.9				
United Kingdom	14.0	71.0	55.0	20.0	20.0	20.0				

(U) Related RDT&E: PEs 0604800N & 0604800F: Milestone II for a joint follow-on engineering & manufacturing development (E&MD) program for the Joint Strike Fighter (JSF) is planned in FY 2000. The follow-on program will develop a tri-service family of aircraft from concepts proven under the JAST Program, incorporating affordable technologies transitioned from the JAST Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Joint Strike Fighter Program, PE 0603800E, Project JA-01

(U) **Schedule Profile**:

Planned	Milestones
Jan 96	Complete Large Scale Propulsion Model Testing.
Oct 96	Award concept demonstration contract.
Mid 97	Complete preliminary design of Concept Demonstration Aircraft.
Early 98	Complete detailed design of Demonstration Aircraft.
Mid 98	Complete detailed design of Demonstration Aircraft.
FY 99	Begin flight demonstrations.
FY 2001	End concept demonstration phase.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Dual Use Applications Program,
PE 0603805E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Dual Use Applications Programs GC-01	0	250,000	195,000	175,000	145,000	75,000	0	0	0	N/A

(U) **Mission Description:** The Dual-Use Application Program will build on the successes of past programs that demonstrated a highly successful, fundamentally new and effective approach to the acquisition of technology for the DoD--one based on entrepreneurial leverage of superior commercial technologies using cost sharing and government/industry partnership. Each of the almost 130 military development projects established using this approach validated the advantage of some new commercial technology or business techniques applied to DoD. All were selected and managed outside of the traditional defense acquisition mold; most use completely new legal instruments and authorities.

(U) From a military perspective, dual use programs offer access to superior technologies that are currently restricted to commercial use. Other benefits include leveraged funding (an opportunity for cost sharing of at least 50% with the commercial partner), attracting new players (other than the traditional military contractors), commercialization (e.g., cost reduction), and the efficiencies of integrating military and commercial industrial processes. The commercial sector places particular emphasis on system upgrades, rather than the expensive development of new systems. Upgrading demands continuity of the manufacturing and service base as well as attention to protocols and standards to allow the introduction of new components, software or add-on units. While conventional defense industry has had problems with these activities, dual use programs exploit the ability of the commercial world to accomplish them.

(U) The mission of the Dual Use Applications Program (DUAP) is not to continue the past experiment, but rather to institutionalize these concepts in the Services acquisition systems. DUAP is built around a three-year process of transition designed to firmly root the principles of expanding dual-use leverage throughout the DoD, not just at the R&D level. Projects will be solicited as government/industry partnerships and selected to meet Service needs. They will be managed by the Services under the new authorities and methods, along a clear path for incorporation of those technologies in deployable systems.

(U) The responsibility for the implementation of this new initiative is assigned to the Joint Dual-Use Project Office (JDUPO). The JDUPO was established on December 9, 1995, by a Memorandum of Understanding (MOU) between the Science and Technology Executives of the Army, Navy, Air Force, the Director of DARPA and the Director, Defense

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Dual Use Applications Program, PE 0603805E, Project GC-01

Research and Engineering (DDR&E). The mission of this office is to make DoD-wide, militarily-focused investments in dual-use technologies. By so doing, the joint office will ensure that dual use technology strategies will be implemented by the Military Departments and that the technology products developed will directly address the needs of its customer, the warfighter. The JDUPO is under the directorship of DARPA during FY 1997. Beginning with FY 1998, this program will transition to the Military Departments under the direction of the DDR&E.

(U) Use of innovative, non-procurement agreements such as Other Transactions and Cooperative Agreements offer a more creative mechanism between the government and the performing consortium than conventional contract practices. These type of agreements allow a commercial-like business practice which is conducive to a dual-use effort affording both parties the flexibility of negotiating the essential points without the restrictive terms of the FAR and other regulations directed at procurement type purchases. These non-procurement agreements will be an integral part of this dual use program.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Technology thrusts for this program will be jointly selected and built around the following criteria: (1) an explicit, identified need from a military user or systems office; (2) the potential of dual-use as an efficient approach to meeting that need; and (3) a viable transition plan for incorporation of the technology into a military system.
- A set of the most pressing military needs which are best addressed through the strategy of dual use has been identified. Although the final selection process is not yet complete, the following is representative:
  - Eliminate limitations on battlefield electronics (communications, computers, night visions scopes, etc.) due to lack of available portable energy; lower maintenance cost and increase reliability of military platforms such as the Advanced Amphibious Assault Vehicle (AAAV), the M1A1 (Abrams tank), and the Landing Craft Air Cushion Vehicle.
  - Reduce development, procurement and operating costs of sensor components, sensor architectures, and multi-sensor integration for military operations such as reconnaissance, perimeter monitoring, guidance, and target detection.
  - Reduce the probability of acoustic detection for military platforms.
  - Protect the combat soldier against chemical, biological and electromagnetic threats.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE May 1996
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Dual Use Applications Program, PE 0603805E, Project GC-01

- Increase reliability and system survivability through use of high power, high temperature electronics.
- Increase the ability of the military to manipulate, exchange, convey, protect and, most importantly, rapidly understand battlefield information.
- Reduce structural weight in aircraft, vehicles and ships at an affordable cost.
- Enable secure, multimedia wireless communications to the soldier on the battlefield.

• This set is in various stages of evaluation and is being thoroughly reviewed by the Military Departments and DARPA. Specific technology thrusts will be built around a subset of these needs. Upon approval of the final selections by the Joint Steering Committee, a BAA will be published inviting proposals.

• Based on the competition announcement, scheduled to be printed not later than the fourth quarter of FY 1996, proposals responding to the selected technology thrusts will be chosen during the first quarter of FY 1997. Technical and administrative management of these projects will be assigned to a military organization with ties to expected users. The Military Service representatives within the JDUPO will actively pursue, in an on-going fashion, continued working relationships between the Service end users and the developers to ensure complete military compatibility with final products within the goals of the program (performance, affordability, and accessibility. Projects will be performed primarily with industry and/or industry teams with support from universities and military laboratories as appropriate.

• During the third quarter of FY 1997, new technology thrusts for FY 1998 will be chosen following the same procedures outlined in the MOU.

(U) <u>FY 1998 Program</u>:

• Based on the competition announcement to be printed in the last quarter FY 1997, proposals responding to the selected technology thrusts will be evaluated and the highest ranked will be awarded. Technical and administrative management of these projects will be assigned to a military organization with ties to expected users. During third quarter FY 1998, new technology thrusts for FY 1999 will be chosen and a BAA published not later than fourth quarter, FY 1998.

(U) <u>FY 1999 Program</u>:

• Based on the competition announcement, printed in the last quarter FY 1998, proposals responding to the selected technology thrusts will be evaluated and the highest ranked will be awarded. Technical and administrative management of these projects will be assigned to a military organization with ties to expected users. During third quarter FY 1999, new technology thrusts for FY 2000 will be chosen and a BAA published not later than fourth quarter, FY 1999.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Dual Use Applications Program,
PE 0603805E, Project GC-01

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	250.0	195.0	195.0
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0	250.0	195.0	175.0

(U) **Change Summary Explanation:**

FY 1999 Decrease reflects a phase down of the program.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE: May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 6 Management Support

R-1 ITEM NOMENCLATURE
Small Business Set Aside (R&D),
PE 0605502E

COST *(In Thousands)*	FY 1996	FY 1997	FY1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Small Business SB-01	37,340	0	0	0	0	0	0	0	Continuing	Continuing

(U) **Mission Description:** The Small Business Innovative Research (SBIR) program was mandated under PL 102-564, to provide small businesses federal research funds to develop innovative solutions to problems that will assist the DoD in performing its mission. Each federal agency with an annual extramural R&D budget exceeding $100 million is required to participate in the SBIR program by setting aside a percentage of their budget. These funds will be awarded to small businesses through a competitive, three phase process (Phase I, Phase II, and Phase III). Topics in scientific areas that support DoD technology areas and DoD critical technologies are published in an open solicitation twice a year.

(U) DARPA encourages the submission of SBIR proposals whose technology development will support DARPA's mission of advancing state-of-the-art defense technology and that have a strong likelihood of being successfully integrated into the commercial marketplace.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- DARPA participated in the Washington, DC and Dallas, TX National High Tech Conferences. DARPA's FY 1996 SBIR budget of $41M was used to support Phase I and Phase II efforts. DARPA has participated in both the FY 1996 DoD SBIR solicitations and expects to award approximately 100 Phase I efforts from these solicitations.

(U) FY 1997 Plans: N/A

(U) FY 1998 Plans: N/A

(U) FY 1999 Plans: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 6 Applied Research	Small Business Innovative Research Administration, PE 0605502E, SB-01

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	N/A	N/A	N/A
Appropriated	N/A	N/A	N/A	N/A
Current Budget	37.3	N/A	N/A	N/A

(U) **Change Summary Explanation:**

FY 1996 Increase reflects reprogramming of program funds into one PE for SBIR compliance.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 6 RDT&E Management Support

R-1 ITEM NOMENCLATURE
Management Headquarters (R&D),
PE 0605898E, Project MH-01

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Management Headquarters MH-01	34,099	36,369	37,315	38,486	39,147	39,991	38,700	38,700	Continuing	Continuing

(U) **Mission Description:** This program element is budgeted in the Management Support Budget Activity because it provides funding for the administrative support costs of the Defense Advanced Research Projects Agency. The funds provide for personnel compensation for civilians as well as costs for building rent, physical and information security, travel, supplies and equipment, communications, printing and reproduction. In addition, funds are included for reimbursing the Military Services for administrative support costs associated with contracts undertaken on the Agency's behalf.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Funding under this program element in FY 1996 supported management and administration for the RDT&E programs assigned to DARPA. The majority of the funds were required for the pay of personnel who operate the Agency. The funding level reflects the rental costs associated with the expansion of office space, and the related support and security requirements.

(U) FY 1997 Program:

- DARPA will continue the management and administrative support efforts for headquarters at approximately the same level as FY 1996. Increases reflect annualization of increased support begun in FY 1996.

(U) FY 1998 Program:

- DARPA will continue the management and administrative support efforts for headquarters at approximately the same levels as FY 1997. The funding level reflects increased payroll requirements.

(U) FY 1999 Program:

- DARPA will continue the management and administrative support efforts for headquarters at approximately the same levels as FY 1998. The funding level reflects increased payroll requirements.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE: May 1996

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 6 RDT&E Management Support

R-1 ITEM NOMENCLATURE
Management Headquarters (R&D),
PE 0605898E, Project MH-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	32.6	36.4	37.3	38.5
Appropriated	32.6	N/A	N/A	N/A
Current Budget	34.1	36.4	37.3	38.5

(U) **Change Summary Explanation**:

FY 1996 Increase reflects minor repricing and enhanced security requirements.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

Format C-7: Industrial Base Program Funding

(Current $ Millions)

Defense Advanced Research Projects Agency

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Manufacturing Related Technology Investments									
Mantech/Industrial Preparedness									
0603570E	208.067	181.623	0	0	0	0	0	0	0
0603739e	153.749	153.573	120.159	88.455	65	61.951	50	47.5	45.754
0603745E	88.327	36.531	0	0	0	0	0	0	0
0603746E	40.418	46.351	37.408	50	0	0	0	0	0
0603747E	14.17	14.694	0	0	0	0	0	0	0
0603850E	0	0	250	195	175	145	75	0	0
Preserving Industrial Capabilities									
Industrial Facilities									
Industrial Analysis and Planning									
Title III Projects									

SECTION IV

FACILITIES CONSTRUCTION AND MAINTENANCE

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0601101E - Defense Research Sciences

Project: MS-01

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Basic Research	7.972	0	0	0	0	0	0	0	0
Subtotal	7.972	0	0	0	0	0	0	0	0
Project Total	7.972	0	0	0	0	0	0	0	0
PE Total	7.972	0	0	0	0	0	0	0	0

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0602712E - Materials & Electronics Technology

Project: MPT-01

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Exploratory Development	7.779	9.128	9.946	3.768	2.19	0	0	0	0
Subtotal	7.779	9.128	9.946	3.768	2.19	0	0	0	0
Project Total	7.779	9.128	9.946	3.768	2.19	0	0	0	0
PE Total	7.779	9.128	9.946	3.768	2.19	0	0	0	0

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0603226E - Experimental Evaluation of Major Innovative Technologies

Project: EE-21

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Advanced Development	10.575	0	0	0	0	0	0	0	0
Subtotal	10.575	0	0	0	0	0	0	0	0
Project Total	10.575	0	0	0	0	0	0	0	0

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0603226E - Experimental Evaluation of Major Innovative Technologies

Project: EE-36

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Advanced Development	1.541	2.5	0	0	0	0	0	0	0
Subtotal	1.541	2.5	0	0	0	0	0	0	0
Project Total	1.541	2.5	0	0	0	0	0	0	0
PE Total	12.116	2.5	0	0	0	0	0	0	0

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0603569E - Advanced Submarine Technology

Project: AS-01

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Advanced Development	0.05	0	0	0	0	0	0	0	0
Subtotal	0.05	0	0	0	0	0	0	0	0
Project Total	0.05	0	0	0	0	0	0	0	0
PE Total	0.05	0	0	0	0	0	0	0	0

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0603570E - Defense Reinvestment

Project: PT-01

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Advanced Development	0	4.581	0	0	0	0	0	0	0
Subtotal	0	4.581	0	0	0	0	0	0	0
Project Total	0	4.581	0	0	0	0	0	0	0
PE Total	0	4.581	0	0	0	0	0	0	0

Format E-10: Environmental Security Technology

(Current $ Millions)

Defense Advanced Research Projects Agency

Program Element: 0603745E - Semiconductor Manufacturing Tech (SEMATECH)

Project: EM-01

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Pollution Prevention									
Research									
Advanced Development	9	3.6	0	0	0	0	0	0	0
Subtotal	9	3.6	0	0	0	0	0	0	0
Project Total	9	3.6	0	0	0	0	0	0	0
PE Total	9	3.6	0	0	0	0	0	0	0
Grand Total	36.917	19.809	9.946	3.768	2.19	0	0	0	0

SECTION V

MANPOWER/PERSONNEL DATA

Format F-10: Civilian Employment Levels and Associated Payroll Costs

(End Strength, Current $ Thousands)

Defense Advanced Research Projects Agency

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Research and Development									
Direct Hire (Civilian Workyears)									
US Citizens									
Number	190	210	210	210	210	204	200	200	200
Cost ($ 000)	18334	21366	23206	23854	24625	24877	25301	26141	26756
Total Direct Hire									
Number (00's)	190	210	210	210	210	204	200	200	200
Cost ($ 000)	18334	21366	23206	23854	24625	24877	25301	26141	26756
Total Civilian Workyears									
Number (00's)	190	210	210	210	210	204	200	200	200
Cost ($ 000)	18334	21366	23206	23854	24625	24877	25301	26141	26756
Other Costs	175	100	0	0	0	0	0	0	0
Total Costs ($ 000)	18509	21466	23206	23854	24625	24877	25301	26141	26756
End Strength	196	217	217	217	217	211	207	207	207

SECTION VI

DEFENSE INFORMATION INFRASTRUCTURE

Format G-1: DII Resources (Detail)

DII AREA: Science and Technology

Defense Advanced Research Projects Agency
Science and Technology

Category 7
AIS: Small and Non-system funding

Current $ in Millions/End Strength in (000s)

Resource Baseline	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY2003
Development and Modernization All appropriations are RDT&E Funding Source Breakout									
62301E	4.039	7.585	4.521	4.521	4.521	4.521	4.521	4.521	4.521
TOTAL-Dev./Mod.	4.039	7.585	4.521	4.521	4.521	4.521	4.521	4.521	4.521
Current Services All appropriations are RDT&E Funding Source Breakout									
63226E	4.105	4.250	4.798	4.798	4.798	4.798	4.798	4.798	4.798
TOTAL-Current Services	4.105	4.250	4.798	4.798	4.798	4.798	4.798	4.798	4.798
Total Resources (Dollars)	8.144	11.835	9.319	9.319	9.319	9.319	9.319	9.319	9.319
Manpower	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Non-Add	0	0	0	0	0	0	0	0	0

Format G-2: DII Resources (Summary)
DII AREA: Science and Technology

Defense Advanced Research Projects Agency

Summary Report - see Format G-1

Category 7
AIS: Small and Non-system funding

Current $ in Millions/End Strength in (000s)

Resource Baseline	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY2003
Development and Modernization All appropriations are RDT&E Funding Source Breakout									
62301E	4.039	7.585	4.521	4.521	4.521	4.521	4.521	4.521	4.521
TOTAL-Dev./Mod.	4.039	7.585	4.521	4.521	4.521	4.521	4.521	4.521	4.521
Current Services All appropriations are RDT&E Funding Source Breakout									
63226E	4.105	4.250	4.798	4.798	4.798	4.798	4.798	4.798	4.798
TOTAL-Current Services	4.105	4.250	4.798	4.798	4.798	4.798	4.798	4.798	4.798
Total Resources (Dollars)	8.144	11.835	9.319	9.319	9.319	9.319	9.319	9.319	9.319
Manpower	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Non-Add	0	0	0	0	0	0	0	0	0